Morphosyntactic Development in a Second Language:

An Eye-tracking Study on the Role of Attention

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THESIS

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This thesis is dedicated to my partner, Dustin Manning. Your unwavering support has helped me through the toughest of moments. Thank you for always being there.

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BII

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

LIST OF ABBREVIATIONS

H	hypothesis
IE	Input Enhancement
L2	second language
ms	milliseconds
PI	Processing Instruction
RQ	research question
§	section
SI	Structured Input Practice

SUMMARY

The current study investigated the role of overt attention, as measured by eye-tracking, in the learning of morphosyntax by adult second language learners. While previous research in the field of adult second language acquisition has examined the cognitive variable of attention and deemed it an important component with regard to learning (Robinson, 1995; 2003; Schmidt, 1990; 1995; 2001; Tomlin & Villa, 1994), there is a lack of agreement on how to best define attention and how to best operationalize and measure this construct.

The present study has adopted theories and methodologies from cognitive science to address these two issues. First, this thesis incorporates a theory from cognitive science that identifies attentional mechanisms as either external or internal, which can be tapped into through the use of different manipulations (Chun, Golomb, & Turk-Browne, 2011). These manipulations were incorporated into separate language learning paradigms through the use of two instructional interventions inspired by Input Enhancement (Sharwood Smith, 1991, 1993) and Structured Input Practice (VanPatten, 2004; VanPatten & Cadierno, 1993b and elsewhere). Next, in order to address methodological concerns, the current study extended recent research that has incorporated eye-tracking as a direct concurrent measure of over attention while learners interact with their second language (Godfroid, Boers, & Housen, 2013; Godfroid, Housen, & Boers, 2010; Godfroid & Uggen, 2013) to a new language feature, morphosyntax. In particular, this project examined the learning of Spanish direct object-pronouns. This study investigated how external and internal manipulations of attention affected attentional allocation and whether these manipulations resulted in learning. Additionally, this project explored the

relationship between attention and the development of morphosyntax in adult learned second languages.

The principle findings of this study are (1) external and internal manipulations of attention do in fact change how learners allocate their attention when processing their second language, and (2) learning effects are evident under both external and internal manipulations of attention. Results indicated that attentional allocation is indeed affected by instructional interventions and in some cases may indirectly lead to learning. However, the relationship between attention and the learning of morphosyntax may be mediated by other contributing factors to the complex phenomena of adult second language acquisition.

1. INTRODUCTION

1.1 Background

Learning a second language (L2) is arguably one of the most difficult and complex tasks for the adult mind. Since the 1950's, researchers have investigated adult language learning and development in an attempt to isolate factors that may either benefit or negatively impact these processes. Such investigations have included research into a wide range of factors that potentially affect learning and development including: (a) linguistic factors, for instance L1/L2 similarity (e.g., Andersen, 1983), (b) social factors, such as social distance from the target culture (e.g., Schumann, 1976), (c) affective factors, for example, motivation and anxiety (e.g., Dörnyei & Clément, 2001; Dörnyei, 2005), and (d) cognitive factors, for instance, language aptitude (e.g., Skehan, 1991), awareness (e.g., Schmidt, 1995), attention (e.g., Tomlin & Villa, 1994), declarative and procedural memory (e.g, Ullman, 2005), and working memory (e.g., Mackey, Adams, Stafford, & Winke, 2010). Although numerous researchers have highlighted the importance of investigating the interaction of various factors and how this type of interaction may account for L2 development (Larsen-Freeman, 2006; Robinson, 2001a; Robinson, 2002; Robinson, 2007; Robinson, 2012) one particular cognitive factor that has been widely assumed to be necessary and sufficient for development to occur is *attention.* This assumption comes from both theoretical (Leow, 2001a; Leow, 1998; Leow, 2000; Robinson, 1995; Robinson, 2001b; Robinson, 2003; Schmidt, 1990; Schmidt, 1995; Schmidt, 2001; Tomlin & Villa, 1994) and applied perspectives (Alanen, 1995; Doughty & Williams, 1998; Doughty, 2003; Han, Park, & Combs,

2008; Lee & Huang, 2008; Leow, 2001b; Leow, Egi, Nuevo, & Tsai, 2003; Sharwood Smith, 1991; Sharwood Smith, 1993; VanPatten, 2004; VanPatten & Cadierno, 1993b). However, due to methodological limitations, empirical research on the role of attention in L2 development has yet to converge on robust, informative conclusions. Thus, the assumption that attention to L2 linguistic target forms accounts for development of those forms has yet to be supported by direct empirical evidence.

1.2 Statement of the Problem

One open question that has prompted investigation into the role of attention within the field of L2 development is: why do discrepancies exist between *input* and *intake*? Where *input* is any utterance heard or read in the L2 (e.g., through listening to a native speaker of the L2, or through reading a text in the L2, among other language-related contexts) and *intake* is the linguistic information in those utterances that is cognitively registered and further processed (Robinson, Mackey, Gass, & Schmidt, 2012). That is, what allows learners to incorporate specific aspects of the input that they encounter into their developing language system (thus turning it into *intake*) and ignore others as they process input in their L2?

There are two prominent theoretical models that claim the construct of attention, i.e., the focus of cognitive operations and mechanisms on a particular aspect of the input, is necessary for converting said input to intake (Robinson, 1995; 2003; Schmidt, 1990; 1995; 2001) and at least one that claims that attention is both necessary and sufficient (Tomlin & Villa, 1994). Note, however, that much of the argumentation among these perspectives hinges on awareness, i.e., whether information is consciously registered and can be later

verbalized, without thoroughly addressing the specific role of attention, even though all three models agree that attentional mechanisms are active during input processing.

Furthermore, much of the work within the instructed L2 acquisition literature—i.e., research dedicated to the implementation of pedagogical materials and the examination of the effects these materials have on development—has relied upon the premise that attention to target forms results in development (Doughty & Williams, 1998; Doughty, 2003). Thus, the evidence for claims about the role of attention in L2 development have been put forth by two main sources: (a) empirical investigations designed to test aspects of theoretical L2 models that include attention as a key construct and (b) research under the framework of instructed L2 acquisition that has been designed to test pedagogical interventions that aim to manipulate attention. However, as discussed in the following sections, neither of these approaches has provided *direct* empirical evidence to corroborate these claims.

In order to best address the open question of whether increased attention leads to increased L2 development, I will more fully explore the following topics in this introduction: In § 1.2.1, I will provide an overview of the theories related to attention in L2 acquisition and the indirect empirical work that supports these theoretical positions. Next, in § 1.2.2, I will briefly introduce the relevant but, again, indirect empirical work from instructed L2 acquisition research. In order to advance our knowledge and design an experiment that can directly test claims made by theories about attention and L2 linguistic development, we need a full understanding of attention, its role in learning and how it can be measured from cognitive science, which I will lay out in § 1.2.3. Finally, I will specify the

open issues related to the role of attention in L2 development and preview the design of the current study and discuss how it aims to address those open questions in § 1.3.

1.2.1 Theoretical and Empirical Second Language Research

There are three prominent perspectives that have attempted to relate L2 development—i.e., the process of turning input to intake—to attentional mechanisms, each of which has attempted to refine the previous model. The first theoretical perspective was Schmidt's *Noticing Hypothesis* (1990; 1993; 1994; 1995; 2001). This hypothesis claimed that attention to and awareness of specific aspects of input was a necessary condition for turning input to intake. However, according to Schmidt, awareness was the necessary *and sufficient* condition for learning. Following the publication of the *Noticing Hypothesis*,

Tomlin and Villa (1994) argued that L2 learning could take place without awareness based on a more fine-grained model of attention from cognitive science, referring to the three Three-tiered Attentional System (Posner & Petersen, 1990). Thus, in direct contrast to Schmidt, Tomlin and Villa argued that *attention* was actually a necessary and sufficient condition for learning. As a way of reconciling these models, Robinson (1995; 2003) proposed a merger of constructs from Schmidt's *Noticing Hypothesis*, Tomlin and Villa's adaptation of the *Three-tiered Attentional System* and aspects of human memory (as described by Cowan, 1988; 1993). This model incorporated both a fine-grained conceptualization of attention and a necessary and sufficient role for awareness as a way of accounting for how certain aspects of L2 input are turned into intake.

Shortly after the publication of the above-mentioned models, empirical research emerged that attempted to lend support to claims from these models by creating experimental conditions that aimed to operationalize constructs such as *alertness*,

orientation, and *detection* (Leow, 1998), manipulating task instructions in order to *focus attention* (Gass, Svetics, & Lemelin, 2003) or by collecting think-aloud protocols (i.e., concurrent verbal reports provided by participants while they complete a task) to categorize learners' awareness into levels of *noticing* or *understanding* (Leow, 1997; 2000; 2001b). However, with regard to the effects of attention, this research has only provided indirect evidence for the widely held assumption that attention leads to L2 development. That is, due to methodological limitations associated with the use of non-concurrent measures and think-aloud protocols as a measurement of attentional processes, these studies lack a reliable measure of attention during task completion, and, therefore, it cannot be concluded from these studies that increased attention leads to developmental gains.

In recent years, however, the relationship between attention, awareness and learning has been investigated from a L2 perspective through the use of eye-tracking as a concurrent measure of attention. Godfroid and colleagues (Godfroid, Boers, & Housen, 2013; Godfroid, Housen, & Boers, 2010; Godfroid & Uggen, 2013) have provided direct empirical evidence that attention to forms leads to development of those forms. This research has provided an initial step in more fully investigating the role of attention during learning by measuring attention with a reliable concurrent measure, rather than assuming task demands have manipulated attention. However, these studies have mainly focused on the development of non-rule based L2 forms, such as nonce vocabulary items. With only one study examining the relationship between attention and development of morphological features of German as an L2 (through the study of German irregular verb

forms), the relationship between attention and morphosyntactic development still remains relatively open for investigation.

1.2.2 Indirect Evidence From Instructed Second Language Acquisition

Further indirect evidence for the role of attention may be gleaned from studies that examine the efficacy of L2 instructional interventions that were developed based on the premise that increased attention and awareness leads to increased L2 development (Doughty & Williams, 1998). Two instructional interventions that have been created based on this premise are: (1) *Input Enhancement* (Sharwood Smith, 1991; 1993) where the L2 input provided to learners is textually enhanced through a font change, for example, and (2) *Processing Instruction* (VanPatten, 2002; 2004; 2005; 2007; VanPatten & Cadierno, 1993a) where the L2 input is presented in such a way that learners must process a form for meaning in order to respond to practice items.

Empirical investigations related to both Input Enhancement (Alanen, 1995; Bowles, 2003; Izumi, 2002; Leow, 2001b; Leow et al., 2003; Park, 2005) and Processing Instruction (Farley, 2001a; Farley, 2004; Keating & Farley, 2008; Morgan-Short & Bowden, 2006; VanPatten & Borst, 2012) have mainly relied on non-concurrent measures as a way of assessing development. That is, these studies have administered a pre-test—instructional intervention—post-test design, where any gains from pre to post-test are attributed to the instructional intervention. Although this design shows whether learners make linguistic gains or not, the lack of an implementation of a concurrent measure of attention restricts these studies from showing whether learner attention was manipulated by the intervention, as assumed.

Thus, the majority of L2 empirical work, with the exception of Godfroid's research, does not provide direct evidence about the role of attention during learning. This dearth of direct evidence is apparent in two broad categories of empirical investigations; those that have been designed to (a) answer questions related to theoretical models of attention, and (b) answer questions related to the effectiveness of instructional interventions. A similar problem can be identified within both of these research approaches: a lack of concurrent measures of attention. Effects of attentional manipulations are not directly measured while learners interact with the target language and thus any learning gains evidenced cannot be directly attributed to these manipulations. However, this problem can be remedied by turning to research from cognitive science and adapting theories and methods used to assess attention to research on L2 development.

1.2.3 Research on Attention in Cognitive Science

The study of attention has had a long history in the field of cognitive science (Chun, Golomb, & Turk-Browne, 2011; Raz & Buhle, 2006) and has generally shown attention to have beneficial effects on learning. Indeed, various models that account for different types of learning, e.g., associative learning, and category learning, include attention as a key construct (Ashby & Maddox, 2005; Jiménez & Méndez, 1999; Pearce & Hall, 1980; Pearce & Mackintosh, 2010; Rehder & Hoffman, 2005a; Rehder & Hoffman, 2005b; Tanaka, Kiyokawa, Yamada, Dienes, & Shigemasu, 2008 among others). The assumption that attention is necessary for L2 development appears to be consistent with evidence from other types of learning and further motivates a more thorough consideration of extant perspectives on attention in cognitive science.

Although the L2 acquisition field has previously conceptualized attention as the three-tiered network of alertness, orientation and detection (Posner & Petersen, 1990; Tomlin & Villa, 1994), it has not considered some more recent accounts of attention. A recent review of work in attention (Chun et al., 2011) suggests, as other accounts have before, that attention may not be one unitary system comprised of multiple mechanisms but may be understood as multiple attentional systems: an *external attentional system*, which is affected by modality-specific exogenous cues, and an *internal attentional system*, which is affected by endogenously generated information. Effects on the external attentional system, for example, are observed when the saliency of visual stimuli is manipulated (Corbetta & Shulman, 2002; Egeth & Yantis, 1997) and effects on the internal attentional system are found when the demands of a task that elicits responses to stimuli are manipulated (e.g., Braver, Reynolds, & Donaldson, 2003; Leber, Turk-Browne, & Chun, 2008; Leber, 2010). Empirical evidence for the distinction between these systems comes from a double dissociation in the literature where manipulations of attention through exogenous cues (i.e., external cues) does not affect the internal attentional system and manipulations through endogenous cues (i.e., internal cues) do not affect the external attentional system (e.g., Lavie, Hirst, de Fockert, & Viding, 2004; Pashler, 1994, see § 2.8 for further discussion of the empirical work supporting this distinction). Therefore, while these systems may interact and communicate there is evidence for separability (Chun et al., 2011). The distinction between external attention and internal attention may provide a relevant and interesting contribution to theories about attention in L2 development, given that specific L2 instructional interventions can be categorized as external or internal manipulations of attention as will be discussed further below.

1.3 Open Issues in Second Language Research

Considering the current status of research on attention and L2, as well as updated conceptualizations of attention in cognitive psychology, I have identified the following open questions with regard to attention: *Does attention to a target form lead to L2 development of that form?* This question is motivated by the fact that the construct of attention figures prominently in theoretical models of L2 acquisition, as well as in the design of instructional interventions aimed at promoting L2 learning yet, the widely held assumption that greater attention leads to morphosyntactic L2 development has not yet been directly tested using concurrent, non-reactive methods. *How do external and internal manipulations of attention affect L2 linguistic development?* Evidence from cognitive science has shown that external and internal manipulations of attention tap different attentional mechanisms and therefore may lead to qualitative differences in attentional allocation with regard to language processing, which in turn may lead to specific patterns of L2 linguistic development as a result of these different manipulations.

In order to address these open issues, the present study aims to incorporate eye-tracking as a direct concurrent measure of attention during practice with a novel linguistic target form. The inclusion of this robust methodology can provide uninterrupted monitoring of participants' overt attentional allocation while they interact with learning materials in their L2, thus, providing innovative and *direct* evidence for the claim that increased attention leads to L2 linguistic development. More specifically, L2 learners of Spanish will complete meaningful language practice in Spanish in order to learn direct object clitic pronouns while their eye-movements are recorded.

Furthermore, in order to address how external and internal manipulations of attention affect L2 linguistic development, the current study has incorporated both of these types of manipulations of attention in separate conditions. Thus, this project directly adapted the taxonomy of attention from cognitive science to a L2 learning paradigm. I utilized Input Enhancement—i.e., the manipulation of attention through the augmentation of the visual saliency of the target form—as an external attentional manipulation. Additionally, I employed structured input practice—i.e., a component of Processing Instruction, which consists of the manipulation of attention through task demands—as an internal attentional manipulation. In order to directly measure how attentional allocation is affected by these manipulations, participant eye-movements were also recorded while they processed sentences containing the direct-object clitic pronoun without any manipulation of attention. This within-subjects baseline provided a natural measure of attention to the target form, which was then compared to attention allocated to the target form as a result of either the external or internal attentional manipulations. In order to control for any potential effects of repeated exposure to the target form due to completing the within-subjects baseline followed by either the external or internal manipulation (e.g., habituation), a third condition was designed where participants completed the within-subjects baseline block of trials, and then completed an additional control block of trials with no manipulation of attention (see Chapter 3 for more details with regard to the experimental design). In sum, this interdisciplinary study aims to address open issues within the field of L2 development by adopting both theory and methods from cognitive science.

1.4 Structure of the Dissertation

In order to fully motivate the merging of methodological techniques and theories from cognitive science with research from the field of L2 acquisition, Chapter 2 serves as a review of literature. In Chapter 2, I describe relevant theoretical models of attention and L2 development from L2 acquisition research, as well as empirical investigations from various lines of research within the field of L2 acquisition that provide indirect evidence for the role of attention in L2 development. Additionally, in Chapter 2, I review models of attention from cognitive science and describe basic characteristics about attention assumed across models, as well as present the formal research questions of the study. In Chapter 3, I describe the experimental design, stimuli, materials, procedures and analyses utilized to answer the research questions. In Chapter 4, I report the results of the project with regard to external and internal manipulations of attention and in Chapter 5, I provide an elaborated discussion of those results as they pertain to the research questions as well as the open issues identified in the previous section. Furthermore, in Chapter 5, I will address limitations of the current project and end the discussion with future directions for research and conclusions.

2. REVIEW OF LITERATURE

2.1 Introduction

In order to fully motivate this dissertation project, this chapter serves as a review of relevant literature. Due to the multidisciplinary nature of the project this chapter includes theoretical and empirical research from the fields of L2 acquisition and cognitive science. In § 2.2, I review theoretical models related to attention and awareness from the L2 acquisition literature. Next, in § 2.3, I review empirical research directly related to these theoretical models, and in § 2.4 I describe empirical research that indirectly addresses the role of attention through instructed L2 acquisition paradigms. In § 2.5, I provide an interim summary of models and research related to attention from an L2 acquisition perspective. Afterwards, in § 2.6, I briefly review the history of prominent theoretical models of attention from cognitive science. Then, in § 2.7, I outline some basic assumptions about attention that have emerged from empirical work in cognitive science. Next, in § 2.8, I identify unresolved issues in cognitive science and describe a current model of attention that posits a distinction between external and internal attention. In § 2.9, I incorporate the approaches from the L2 acquisition literature and approaches from the cognitive science literature in an attempt to answer open questions in the L2 field and add to the body of literature on attention in cognitive science. Lastly, in § 2.10 I present the aims, the specific research questions and the hypotheses of the present study.

2.2 Theoretical Models of Second Language Development and Attention and Awareness

2.2.1 The Noticing Hypothesis

The hypothesis that has driven much of the discussion about attention and awareness in the L2 literature is Schmidt's *Noticing Hypothesis* (1990; 1993; 1994; 1995; 2001). As a precursor to positing this influential hypothesis, Schmidt and Frota (1986) published a case study investigating Schmidt's own acquisition of Portuguese as an L3. This study assessed linguistic development and conversational ability through recorded interviews taken at one-month intervals during a five-month stay in Brazil. As an additional measure of development as well as a measure of the influence of external factors, such as instruction, and interaction in Portuguese, the authors presented a qualitative analysis of diary entries during his stay. Based on the results from both the recorded audio and the analysis of the diary entries, the authors posited that an important aspect of whether Schmidt acquired certain structures was related to whether he *noticed* a gap in his own knowledge. That is, whether he was able to notice that the representation of a particular structure in his developing L2 grammar differed from the input he was receiving from native speakers of Portuguese. This process of noticing the discrepancies between the learner's own competence and native speaker input continued to drive Schmidt's way of thinking as evidenced in a series of publications where he more narrowly defines the concept of *noticing* and posits the *Noticing Hypothesis*.

Noticing as defined by Schmidt (1990) is the focal awareness of input. More specifically, noticing is a private—i.e., learner internal—experience that is available for later verbalization. According to Schmidt, noticing is the necessary and sufficient condition

for L2 input to become intake—i.e., what is cognitively registered and available for further processing. Therefore, the noticing hypothesis claimed that "subliminal language learning," (1990, p. 149) or learning without awareness of what is being learned, was impossible. With regard to the construct of attention, Schmidt claimed that attention was necessary but not a sufficient condition for learning. In later publications, Schmidt continued to include attention as a key construct for L2 learning but also claimed that "noticing is nearly isomorphic with attention" (1995, p. 1). That is, from this perspective, whatever is attended becomes available to conscious awareness and should be available for later verbalization. Consequently, this stance reaffirms that attention is a necessary but not sufficient condition for learning.

As a way to account for L2 development that takes place without explicit knowledge of rules, or verbalizable meta-linguistic knowledge about a particular structure, Schmidt (1995) introduced the terms *awareness at the level of noticing* and *awareness at the level of understanding*. Schmidt defined awareness at the level of noticing as "conscious registration of the occurrence of some event" (1995, p. 29), that is, the conscious registration of surface level phenomena or item learning. This is contrasted with awareness at the level of understanding, which refers to "recognition of a general principle, rule or pattern" (1995, p. 29), i.e., a further abstraction of the input related to meaning or system learning. Therefore, according to Schmidt, when L2 development is evident but learners cannot verbalize anything about a noticing event, this is due to having obtained awareness at the level of noticing rather than at the level of understanding.

In sum, the Noticing Hypothesis makes strong claims about the role of awareness, claiming that it is necessary and sufficient for L2 development to take place. With regard to

attention, Schmidt's model posits a crucial and necessary role for attention as a way of accounting for L2 development. That is, attention to input is what leads to noticing events, which in turn leads to development. However, it is clear form Schmidt's work that he does not believe that attention alone can be responsible for L2 development.

2.2.2 The Three-Tiered Attentional Network

Shortly after Schmidt's Noticing Hypothesis was published, Tomlin and Villa (1994) argued for a more fine-grained conceptualization of the construct of attention as related to L2 development. In order to provide this, they applied a three-tiered model of attention, which was adapted heavily from a cognitive neuroscience model (Posner & Petersen, 1990) to L2 acquisition. In this section, I will discuss the three attentional mechanisms put forth in the original model and then discuss how Tomlin and Villa related these mechanisms to L2 acquisition and some potential problems with this adaptation.

The original model, put forth by Posner and Petersen (1990), was posited as a way of "connecting the mental level of description of processes used in cognitive science with the anatomical level common in neuroscience," (p. 25). Therefore, their discussion relies heavily on differentiating functions or mechanisms of attention and consequently relating those functions to regions of the brain. These functions consist of the following three attentional mechanisms: 1) *alerting*, 2) *orientation* and 3) *detection*. Alerting is defined as a state of sustained or heightened attention that allows for the processing of high priority signals in the input. Orientation consists of the foveation of a stimulus—i.e., visually processing a stimulus with the highest level of acuity and consequently improving processing efficiency—and in Posner and Peterson's model refers to the orienting of visual locations in space. The last attentional network of interest posited by Posner and Petersen

is detection. Detection is the process that selects or engages a high priority signal for further processing and causes widespread interference with other cognitive operations.

Tomlin and Villa (1994) adapted Posner and Peterson's model of attention and attempted to directly relate the different mechanisms of attention posited in this model to the process of L2 acqusition. First, they discussed alertness within the framework of L2 acquisition by describing it as a function of motivation. In other words, the more motivated a student is by their learning environment, their instructor or the input with which they are engaging, the higher their level of alertness. Next, Tomlin and Villa claimed that orientation is crucial for better understanding L2 acquisition because the orientation to either a linguistic form or a linguistic function or meaning at the time of acquisition may provide important information about language processing. However, this comparison does not directly apply to Posner and Peterson's original model, which focused on orienting to visual locations in space. For example, the type of task that Posner and Peterson were referring to is one where participants may be asked to find a vertical rectangle in an array of distractor shapes (Posner, 1994). Thus, it is not clear how orienting higher-level controlled processes such as extracting semantic information would relate to performance on that type of task (Simard & Wong, 2001).

Lastly, Tomlin and Villa claimed that detection is essential for L2 acquisition. They stated that detection is the cognitive registration of a connection between a form and its function, which is then stored in learner memory. These form-function connections are then available for other cognitive processes necessary for learning, such as hypothesis formation and testing. Thus, according to Tomlin and Villa, detection, a mechanism of attention, is necessary for learning. Furthermore, Tomlin and Villa argue that none of the

three mechanisms of attention outlined in their model "require awareness, either to operate or as a result of processing," (p. 193). Specifically stating "there is considerable evidence indicating that information can be cognitively detected, even though the individual is not aware of its having occurred," (p. 193). The evidence cited comes from masked semantic priming studies, where participants were able to read target words faster than non-target words after being presented with a semantically related prime but are unable to report having cognitively registered the prime (Marcel, 1983). Thus, participants are unaware of having read the prime, but facilitation effects, in the form of faster reaction times, were evident. This adaptation of Posner and Petersen's model puts Tomlin and Villa in direct contrast with Schmidt's noticing hypothesis. That is, under this perspective attention to L2 forms is a necessary and sufficient condition for acquisition, whereas awareness or noticing is not.

2.2.3 A Memory-Based Approach

In order to reconcile these views, Robinson (1995; 2003) couched his discussion of the constructs of detection and noticing within Cowan's model of the human memory system (1988; 1993), which consists of short-term working memory and long-term memory. According to Robinson, detection is an attentional mechanism where "detected information can briefly enter working-memory and automatically access previously stored information in long-term memory outside of awareness," (2003, p. 654). However, Robinson also claims that this is only evidence of "unaware recognition, not of learning," (2003, p. 654). Robinson supported Schmidt's view in that noticing was a necessary condition for development to take place. Under Robinson's view, noticing is more narrowly defined as involving "that subset of detected information that receives focal attention,

enters short-term working memory, and is rehearsed,"(2003, p. 655). Rehearsal in this model can either be maintenance (e.g., repeating a piece of information over and over) or elaboration both of which send the information being rehearsed in short-term memory to long-term memory and consequently allow for later verbalization of the noticing event. Figure 1 provides a visual representation of how the different pieces of Robinson's model interact when processing input.

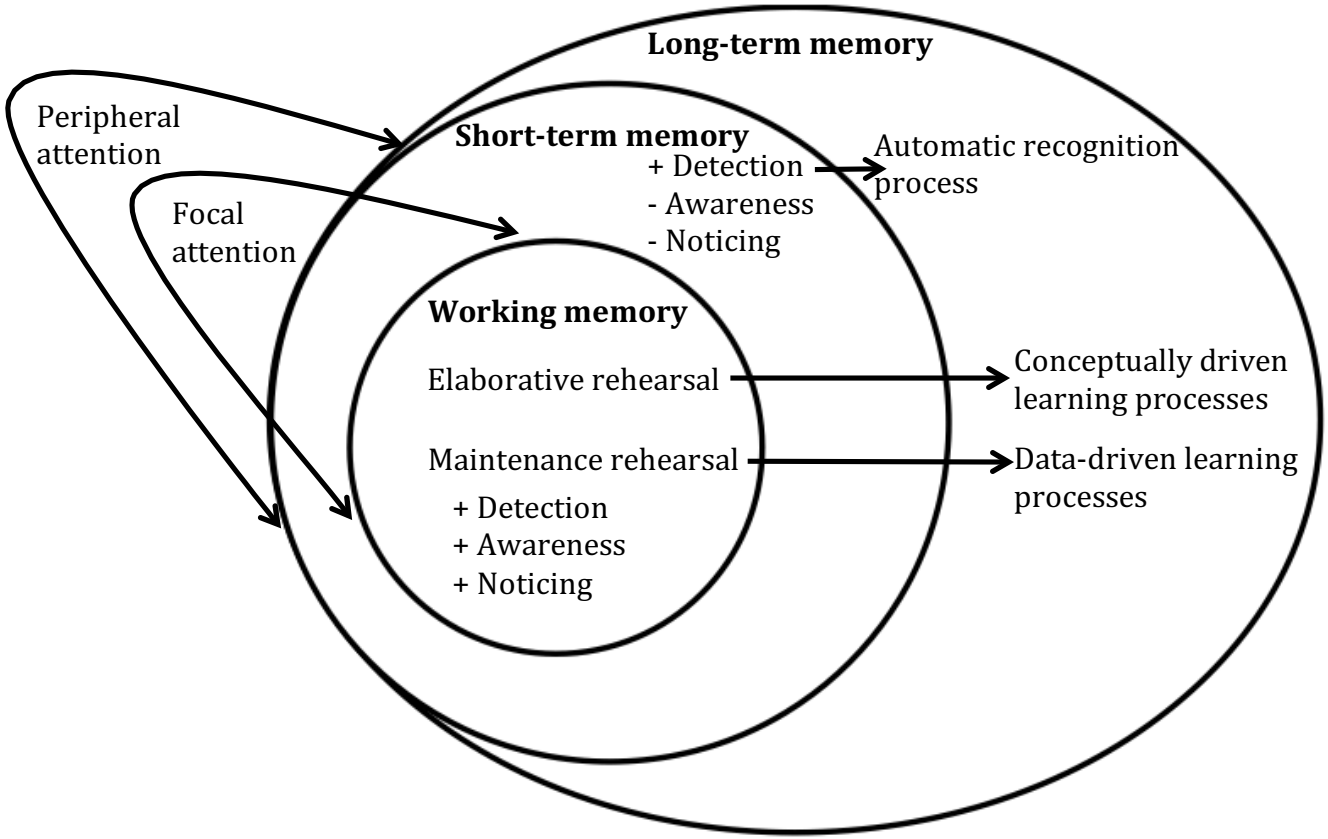

Figure 1. Robinson's model of input processing. Adapted from Robinson 2003's model of input processing, attention, and noticing based on Cowan's model of the human memory system (1988, 1993).

In sum, this model differs from Schmidt's Noticing Hypothesis in that it does not assume that attention and awareness are isomorphic, but rather, posits that detection, an attentional mechanism, and noticing, a level of awareness, are separable yet facilitative processes. That is, focal attention to information in the input is the first step in bringing that information to conscious awareness. Robinson agrees with Schmidt in that although both attention and awareness are considered necessary for learning, only awareness is considered a sufficient condition for learning to take place.

Thus, the three influential models that discuss attention and awareness in L2 acquisition posit a central role for attention in the course of development. Indeed, these models have brought about various lines of empirical work that have aimed to elucidate the roles of attention (e.g., Gass et al., 2003; Leow, 1998) and awareness (e.g., Leow, 1997; 2000; 2001a) and in some cases how the two relate to one another (Godfroid et al., 2010; Godfroid & Schmidtke, 2013).

2.3 Empirical Research Related to Second Language Models of Attention and Awareness

Throughout the years, various empirical investigations have emerged in response to the three models discussed above. The majority of these studies have attempted to categorize learner awareness as awareness at the level of noticing or understanding (e.g., Leow, 1997; 2000; 2001a) rather than directly exploring the role of attention during learning. However, there are at least six empirical studies that have aimed to answer the open question of whether attention to form leads to learning of that form (see Table 1). Leow (1998) attempted to categorize learner attention as one of the three attentional networks outlined in Tomlin and Villa (1994). Gass et al. (2003) created conditions that

aimed to manipulate attention via task demands while participants learned various aspects of Italian. Most recently, Godfroid and colleagues (Godfroid et al., 2010; Godfroid & Schmidtke, 2013) have begun to triangulate data from eye-tracking and retrospective verbal reports as a way of elucidating the relationship between attention and awareness during learning. Furthermore, eye-tracking has been employed to directly address the role of attention in vocabulary (Godfroid et al., 2013) and morphological development (Godfroid & Uggen, 2013). These empirical investigations will be discussed in more detail below.

Table 1

Summary of Investigations on the role of attention in L2 Literature

Study	Linguistic Feature	Measure of Attention	Results
Leow (1998)	Irregular vowel alternation in Spanish	Offline Manipulation of task-demands Online Think-aloud	Groups that completed tasks designed to manipulate attention to the target structure showed greater development.
Gass et al (2003)	Italian (1) vocabulary, (2) wh-movement, (3) indirect and direct object pronouns	Offline Manipulation of task-demands	Groups that completed tasks designed to manipulate attention to the target structure showed greater development.
Godfroid et al. (2010)	Nonce vocabulary	Online Eye-tracking	Attention to a target form was related to subsequent recognition of those forms.
Godfroid et al. (2013)	Nonce Vocabulary	Online Eye-tracking	Attention to a target form was related to subsequent recognition of those forms.
Godfroid & Schmidtke (2013)	Nonce vocabulary	Online Eye-tracking	Attention to a target form was related to subsequent recognition of those forms.
Godfroid & Uggen (2013)	Irregular vowel alternation in German	Online Eye-tracking	Attention to a target form predicted development of that form.

2.3.1 Non-concurrent Measures of Attention

Leow (1998) attempted to operationalize the different mechanisms of the three-tiered attentional model, i.e., alertness, orientation and detection, via task demands and verbalizations from think-aloud protocols. First year learners of Spanish as an L2 (*N* = 83) verbalized their thought process while completing a crossword puzzle task that targeted the production of irregular stem-changing verbs in the 3rd person singular and plural of the Spanish preterit tense.

In order to push learners to attend to this vowel alternation, Leow's experiment required participants to complete one of four crossword puzzle tasks, each of which contained differing instructions. Each of the attentional mechanisms from Tomlin and Villa's model of attention was operationalized via the manipulation of task instructions or the way in which the clues of the crossword puzzle were provided. Learning was assessed with a multiple-choice sentence completion task and a fill-in-the-blank production task. Both of these tasks were administered immediately after completing the crossword, five weeks after and again during a third post-test two months after the treatment.

Findings indicate that groups who completed crosswords where task demands should have brought about detection of the vowel alternation showed significantly more gains when comparing pre-test scores to immediate and delayed post-tests as compared to the other groups. These gains were evidenced on both recognition and production tasks. Furthermore, Leow claimed that excerpts from the think-aloud protocols provided evidence of further processing after the initial detection of the irregular vowel only in the groups whose tasks were manipulated to promote detection.

In sum, the findings from this study suggest that detection, an attentional mechanism, prompted learning of the linguistic target form. Although this operationalization of the three-tiered attentional system does provide positive results in favor of the assumption that attention to form is related to learning, there are methodological limitations that can be identified. First, the operationalization of the different attentional mechanisms via the manipulation of task demands do not map directly onto the definitions of these mechanisms as outlined in Tomlin and Villa. For example, alertness under Tomlin and Villa's model is a state of readiness for processing high priority incoming signals. However, Leow's design does not put the learners in this group in a state of alertness, in fact, no manipulation to task instructions is employed in this condition. Therefore, claims that detection is the most relevant attentional mechanism for L2 development based on a comparison with learners in the alertness condition should be interpreted with caution.

Furthermore, based on the results it is not clear that detection of the vowel alternation occurred, this is due to a lack of a reliable concurrent measure of learner attention. That is, Leow does not triangulate data from individual learner think-aloud protocols and their performance on the task. Moreover, think-aloud protocols have their own set of methodological limitations, such as underreporting—i.e., not verbalizing every thought while completing the task and reactivity—i.e., effects on performance due to verbalizing one's thoughts during task completion (Mackey, 2006). Thus, due to the lack of a clear operationalization of attention and the lack of a reliable concurrent measure of attention, the positive effects of learning the target form cannot be directly attributed to attention to those forms.

Another study that aimed to manipulate learner attention via task demands is Gass, Svetics and Lemlin (2003). This study addressed the question of how differential amounts of attention effect various linguistic domains of Italian as an L2 (i.e., syntax, morphosyntax and the lexicon). The overall experimental design of this study consisted of orienting learner attention via input enhancement and manipulations to instructions provided to participants. Gass et al. assigned native English speakers learning Italian (N = 34) to two treatment groups [+focused attention] and [-focused attention]. The groups interacted with Italian via computer-administered tasks that consisted of various components such as (a) *reading a story*, (b) *the presentation of explicit information about particular language structures* and (c) *practice with the different target structures* (for the [+focused attention] group only).

Each group interacted with input in all three of the linguistic domains (i.e., syntax, morphosyntax and the lexicon). Participants in the [+focused attention] group received input with specific tokens underlined and were instructed to pay attention to those items. Conversely, participants in the [-focused attention] group did not receive underlined tokens and were not instructed to attend to any specific items in the input. Another difference, between the two groups was related to target-structure practice. Only the [+focused attention] group practiced with the target structures. The [-focused attention] completed a task that involved reading the same sentences as the [+focused attention] group but was asked to memorize and repeat non-target words, while the [+focused attention] group completed meaningful practice with the sentences containing the target structures. Results indicated the largest learning gains for the [+focused attention] group with regard to syntactic development and moderate gains for development of

morphosyntax.

The results in Gass et al. are informative and provide positive evidence for the role of attention in L2 development. Although, this study provides an initial step in understanding the differential effects of attention during learning in L2 acquisition, there are certain limitations. One important limitation is that the operationalization of attention is solely dependent on material design and task instructions. That is, the experimental design did not employ any sort of direct measure of attention, but rather assumed that the experimental manipulations (i.e., textual enhancement, instructions to attend to specific forms) would focus participant attention during task completion. Without any direct measure of the amount of attention on the target form it is unclear whether the gains attributed to attention are a result of participants actually attending to target structures or some other difference between experimental conditions, such as practice, which also differed between the groups. Thus, in order to provide direct evidence for the effects of attention, it is necessary to employ a concurrent measure of attention to assure that material design and task instructions actually manipulate learner attention.

2.3.2 Direct Concurrent Measures of Attention

One way to address the limitation of not knowing whether attention has been manipulated is the implementation of eye-tracking as a concurrent measure of overt attention during task completion. By recording participant eye-movements, one can be sure that task design and manipulations to instructions presented to learners actually do manipulate learner attention allocation to the target forms. Indeed, in recent years, Godfroid and colleagues have incorporated online measurements of attention through the recording of participant eye-movements. Godfroid et al. (2010), Godfroid et al (2013) and

Godfroid and Schmidtke (2013) investigated the role of attention in the incidental acquisition of nonce vocabulary items. Participants read passages containing nonce vocabulary items while their eye-movements were recorded. Total fixation time (i.e., the amount of time spent looking at a word, including fixations that are a result of regressing back to the word) was used as a measure of participant attention to the nonce words. Results indicate that total fixation time on a word was a significant predictor of the probability of recognition of those words on a posttest.

An additional study by Godfroid and Uggen (2013) investigated the role of attention in learning a morphological feature of the German verbal system: A stem vowel alternation in 2nd and 3rd person German present tense verbs. Forty-three novice adult learners of German completed a reading task that contained pictures and sentences that included both regular and irregular verbs. Learning was assessed with a picture-cued production task administered before and immediately after the reading task. Results indicate that increased attention to verb forms with the irregular vowel was related to subsequent increased production of those verb forms.

Taken together, results from these studies show that attention as measured by total fixation time during incidental vocabulary acquisition and the acquisition of morphological alternations predicted performance on post-tests with regard to both comprehension and production. By incorporating eye-tracking as an index of attention, this line of research has addressed the methodological issues evident in previous research. That is, this research provides direct evidence related to attentional allocation during task completion, rather than assuming that attention was manipulated by task design. Consequently, the implementation of eye-tracking as an online measure of attention during language

processing is an invaluable contribution to the general line of investigation related to attention and L2 development.

2.3.3 Interim Summary: Second Language Empirical Investigations on Attention

In sum, the above-mentioned studies have all assessed how differential amounts of attention during the completion of L2 practice affect learning outcomes. Interestingly, we can see that of these six empirical investigations, as illustrated in Table 1, Gass et al. is the only study that has not included online measures of attention. The approach taken by Gass et al. is an important first step in answering the open question of whether increased attention leads to increased L2 development. However, without any sort of measurement of attention while participants are learning, it is impossible to know whether attention is manipulated and therefore learning effects cannot be attributed to attention to target forms.

On the other hand, Leow (1998) incorporated think-aloud protocols as a concurrent measure of attention. However, the use of think-aloud protocols has certain limitations associated with it, namely, underreporting and reactivity (Mackey, 2006). Furthermore, as argued by Simard and Wong (2001) and laid out above, there are various flaws in the adaptation of Posner and Petersen's three-tiered attentional system by Tomlin and Villa, therefore making the operationalization of these attentional mechanisms by Leow and consequently, the findings of the study, difficult to interpret with regard to L2 acquisition.

By including eye-tracking as an online measurement of attention during learning, Godfroid and fellow researchers have begun to answer the question of whether attention leads to development. Thus, it appears that with regard to incidental vocabulary learning, increased attention predicts recognition of those forms (Godfroid et al., 2013; Godfroid et

al., 2010; Godfroid & Schmidtke, 2013). Furthermore, with regard to rules that govern morphological alternations, Godfroid and Uggen (2013) have also found a relationship between attention and L2 development of those forms. Based on the current empirical work that has investigated attention using reliable online techniques, the question of whether increased attention to a rule-based morphosyntactic feature will lead to greater learning of that feature is still relatively open for investigation, with only one study examining such features (in the form of morphological alternations). Thus, the present study aims to add to the evidence provided by Godfroid and Uggen and further address that question by examining the acquisition of the agent/theme distinction encoded by direct object pronouns in Spanish.

2.4 Indirect Evidence from Instructed Second Language Acquisition Research

The assumption that attention to linguistic forms leads to learning of those forms is also present within instructed L2 acquisition research. This line of research is dedicated to the design and implementation of instructional interventions and the effects these interventions have on L2 development. Two such instructional interventions that were developed in order to manipulate learner processing of the target language so that attention would be directed to specific linguistic target forms are Input Enhancement and Processing Instruction. Although both of these interventions have driven a large amount of empirical work in the field of L2 acquisition, the results mainly provide indirect evidence for a necessary role of attention due to a lack of concurrent, measures of attention during practice with these interventions.

2.4.1 Input Enhancement

Indirect evidence for the role of attention in L2 development can be found within

the body of research dedicated to the study of the effects of Input Enhancement (IE). This instructional intervention, first introduced by Michael Sharwood Smith (1991, 1993), consists of augmenting the saliency of input that a learner encounters. Since then, at least 16 empirical studies have tested the effects of IE on L2 grammatical and vocabulary development. These studies have generally produced mixed findings (see Table 2). Of the 16 studies listed in Table 2, eight of them have found at least partial positive effects for IE as compared to a non-enhanced condition (see first section of Table 2, Alanen, 1995; Izumi, 2002; Jourdenais, Ota, Stauffer, Boyson, & Doughty, 1995; Lee, 2007; Leeman, Arteagoitia, Fridman, & Doughty, 1995; Overstreet, 2002; Shook, 1994; Wong, 2003). Thus, it appears that IE positively affects development in some cases. Additionally, there are a number of studies that have included attention as part of their research question and of those studies there are six that have included concurrent measures of attention—i.e., think-aloud protocols (Bowles, 2003; Leow, 2001b; Leow et al., 2003; Park, 2005) or in one case eye-tracking (Winke, 2013)—while participants engaged with enhanced input. However, it is difficult to draw robust conclusions related to IE, attention and L2 development across studies due to a high level variability in experimental design (Han et al., 2008). Thus, there are two aspects of this research that merit further discussion (a) a discussion of why results are mixed and (b) a closer analysis of the studies that attempted to measure attention through concurrent measures.

Table 2

Summary of Input Enhancement Studies

Study	N	Proficiency level	Linguistic feature	Experimental[1] groups	Enhancement	Measure of attention	Assessment learning	Results
Studies that have found at least partial positive effects for IE								
Shook (1994)	125	1st and 2nd year university Spanish	Spanish (1) Present perfect (2) Relative pronouns	+IE /+Ins +IE/-Ins -IE	(1) Uppercase (2) Bold	Offline	Recognition Production Fill-in-the-blank	+IE > -IE +IE > -IE
Alanen (1995)	36	n/a[a]	Artificial Finnish (1) locative suffix (2) consonant alternation	+IE RS +IE/RS C	(1) Italics	Online Think-aloud	GJT Production Sentence completion	+IE = -IE +IE/RS > C and +IE
Jourdenais et al. (1995)	14		Spanish Preterit/ Imperfect	+IE -IE	(1) Underline (2) Bold (3) Shadow (4) Different font	Offline	Production Picture-cued	+IE > -IE
Leeman et al. (1995)	22	6th semester university Spanish	Spanish Preterit/ Imperfect	IE CI	(1) Underline (2) Highlight	Offline	Production Debate Essay Cloze-test	 IE > CI IE > CI IE = CI

Izumi (2002)	77	University ESL	English relative clauses	+IE/+Output +IE/-Output -IE/+Output -IE/-Output	(1) Bold (2) Shadow (3) Different font (4) Font size	Offline	Interpretation GJT Production Picture cued Sentence combination Sentence reconstruction	+IE = -IE +IE = -IE +IE = -IE +IE = -IE +IE > -IE
Overstreet (2002)	109	3rd semester university Spanish	Spanish (1) Present progressive (2) Imperfect subjunctive	+IE -IE	(1) Underline (2) Bold (3) Capital	Offline	Recognition Production Free-recall	+IE > -IE +IE > -IE
Wong (2003)	81	2nd semester university French	French past participle agreement	+IE/+S. Input -IE/+S. Input +IE/-S. Input -IE/-S. Input	(1) Underline (2) Bold (3) Font size (4) Italics	Offline	Error correction Production Free-recall	+IE = -IE +IE > -IE
Lee (2007)	259	4th year secondary school English	English passive	+IE/+Familiar -IE/+Familiar +IE/-Familiar -IE/-Familiar	(1) Bold (2) Font size (3) Different font	Offline	Error correction Production Free-recall	+IE > -IE -IE > +IE

Studies that have found no effects for IE								
Leow (1997)	84	2nd semester university Spanish	Spanish formal imperative	+IE/Long -IE/Long +IE/Short -IE/Long	(1) Underline (2) Bold	Offline	Recognition	+IE = -IE
Overstreet (1998)	50	3rd semester university Spanish	Spanish Preterite/ Imperfect	+IE/+Familiar -IE/+Familiar +IE/-Familiar -IE/-Familiar	(1) Underline (2) Bold (3) Shadow (4) Different font	Offline	Production Picture-cued	+IE = -IE
Jourdenais (1998)	116	2nd semester university Spanish	Spanish Preterite/ Imperfect	+IE -IE	(1) Underline (2) Bold (3) Different font	Offline	Production Picture-cued	+IE = -IE
Leow (2001b)	38	1st year university Spanish	Spanish formal imperative	+IE -IE	(1) Underline (2) Bold	Online Think-aloud	Recognition Production Fill-in-the-blank	+IE = -IE +IE = -IE
Bowles (2003)	15	3rd semester university Spanish	Spanish formal imperative	+IE -IE	(1) Underline (3) Bold	Online Think-aloud	Recognition Production Fill-in-the-blank	+IE = -IE +IE = -IE
Leow et al. (2003)	72	1st year university Spanish	Spanish (1) Present perfect (2) Imperfect subjunctive	+IE -IE	(1) Underline (2) Bold (3) Font size	Online Think-aloud	Recognition	+IE = -IE

Park (2005)	24	University ESL	English (1) present perfect (2) pluperfect	+IE -IE	(1) Underline (2) Bold (3) Font size	Online Think-aloud	Production Narrative reconstruction	+IE = -IE
Winke (2013)	55	Intermediate university ESL	English passive	+IE -IE	(1) Underline (2) Color	Online Eye-tracking	Error correction Production Free-recall	+IE = -IE +IE = -IE

Note. IE = input enhancement; I = instruction given to look for enhanced items; RS = Rule Search; C = Control; CI = Communicative Instruction; Long/Short = length of the passage; +/- Familiar = familiarity with the content/topic of the passage; +/- Output = to output practice activities; +/- S. Input = simplified input. [a]This study investigated a semi-artificial language therefore proficiency of this language was not a factor. However, Alanen (1995) did attempt to control for language expertise by including only learners who had previously studied a language or were currently enrolled in a language course.

A more detailed look at the experimental designs employed may explain the mixed findings within this line of research. With regard to assessment type, a wide array of learning assessment measures have been employed making it difficult to draw conclusions across experiments. These measures tap into various L2 skills including: (a) recognition, (b) comprehension, (c) oral production, (d) written production, and (e) form correction. Concerning type of textual enhancement, this also varies widely by study. Whereas in some cases researchers only manipulated one aspect of the text such as (a) font, (b) font size, (c) style—i.e., bold or underline, (d) shadowing, (e) color, other studies have manipulated all of these aspects or some combination of them. Regarding task directions, these were manipulated in variable ways across studies as well. In some cases, participants were instructed to specifically pay attention to the enhanced forms, whereas in other studies they were not. This may have affected participants' natural attentional allocation while interacting with the L2 materials. Lastly, linguistic target form varies across studies, from more complex targets, such as relativization in English, to less complex forms, such as the Spanish imperative, to forms in an artificial mini-language.

An additional cause for a lack of robust conclusions may be related to task type. With the exception of one study (Izumi, 2002), all of the studies listed in Table 2 relied on tasks designed to promote incidental learning of the target forms. These tasks require participants to read passages with target forms textually enhanced in some way. Thus, none of these studies have employed any sort of meaningful practice.

Although, at first glance, it is difficult to discern whether IE results in positive effects for grammar learning due to the various differences across studies, a recent meta-analysis of IE studies (Lee & Huang, 2008) indicated that across studies IE has a small positive effect

associated with it. Lee and Huang (2008) identified 16 IE studies with particular study characteristics. First, in all studies the IE groups read passages that contained target forms that had been enhanced. Second, the comparison groups read passages flooded with target items—i.e., additional target items were incorporated into the text. Within this type of IE study, the authors found a small, reliable positive effect, $d = .22$, for the IE groups versus the comparison groups across studies. The authors suggest that the small effect size found could be due to the lack of a true control group in the studies analyzed—i.e., a group that read the same passage without any type of additional exposure to target items. Thus, IE does appear to be related to L2 development, however due to a lack of true control groups across studies these effects should be interpreted with caution. Consequently, more research is needed in order to fully understand the effects IE has on attention and L2 development.

It is of particular relevance to the present study to consider the research on IE and L2 development in light of whether or not the experimental designs include concurrent measures of attention. While the majority of studies do not include a concurrent measure, there are four studies that employ think-aloud protocols while participants interact with the enhanced input (Bowles, 2003; Leow, 2001b; Leow et al., 2003; Park, 2005) and one that employs eye-tracking (Winke, 2013).

The studies that have employed think-aloud protocols as a concurrent measure of noticing a particular form (Bowles, 2003; Leow, 2001b; Leow et al., 2003; Park, 2005) have found no effects for the use of IE in terms of development as assessed by various pre-versus-post test assessments and no effects for IE in terms of noticing as measured by think-aloud protocols. However, as previously mentioned think-aloud protocols are subject

to underreporting and therefore the results related to noticing of target forms may not completely reveal learners' cognitive processes. It may be the case that learner attention is drawn to the enhanced forms but that think-aloud protocols are not sensitive enough to capture learner attention.

Considering the limitations associated with think-aloud protocols, Winke (2013) is of particular relevance for the present study, given that it is the only IE study to date that has included eye-tracking as a measure of attention while participants interact with enhanced input. Winke's conceptual replication of Lee (2007), investigated the effects of IE on L2 English learners' attention to the passive construction. Participants (N = 55) were divided into two groups; (1) [+IE group]—where the salience of the target form was manipulated by presenting it in red and underlining the form and (2) [–IE group]—where participants were given the same passage but without any sort of textual enhancement. Eye-movements were recorded while participants read passages. By way of assessment, participants completed an error-correction task both before and after the treatment as well as a free-recall comprehension task after the treatment. Results indicated that the [+IE group] had longer total fixation and re-reading times of the target forms during the treatment. However, there were no significant differences between groups on pre-to-post accuracy gain scores on the error-correction task or on the comprehension task. Thus, these findings support the underlying assumption that IE does actually direct learner attention to the enhanced form. However, these findings also suggest that increased attention to the target form does not necessarily lead to increased accuracy in the absence of explicit information.

In sum, results within the body of research on the effects of IE provide some indirect evidence for the assumption that increased attention to form leads to learning of those forms in that 6 of the studies listed in Table 2 have found positive effects for IE as well as the small, positive reliable effect found in the meta-analysis of this line of research (Lee & Huang, 2008). However, due to the overall mixed results in the literature as well as the dearth of reliable concurrent measures of attention to the enhanced input, the results are not convincing. Furthermore, the only study that has employed a direct concurrent measure of attention to enhanced target forms (Winke, 2013) failed to find a relationship between attention to form and learning, although the study did find that attention to enhanced forms was increased compared to non-enhanced forms as measured by total time and re-reading time. However, results of one study are not enough to make robust conclusions about the effectiveness of manipulations of attention caused by IE. Therefore, further research is needed to answer the questions of (a) whether IE actually manipulates learner attention to target forms and (b) whether attention to linguistic forms, due to external manipulations of attention, such as IE, lead to learning of those forms.

Thus, the following motivates the use of IE in the current project: First, this instructional intervention was designed to manipulate learner attention and therefore is relevant to the question of whether attention to form promotes learning of those forms. The present study aims to directly address this question by incorporating eye-tracking as an online measure of attention while learners interact with IE. Second, the present study aims to expand Winke (2013)'s contribution to the IE literature by extending this approach to a new target language (Spanish as an L2), and a new target structure (Spanish direct object pronouns).

2.4.2 Processing Instruction and Structured Input Practice

Another instructional intervention that has a long history in the field of L2 acquisition research and that has provided indirect evidence for the claim that increased attention to linguistic forms leads to learning of those forms is VanPatten's Processing Instruction (VanPatten, 2002; 2004; 2005; 2007; VanPatten & Cadierno, 1993a). This instructional intervention is derived from VanPatten's theoretical model of L2 *Input Processing*, which aims to characterize learners' processing strategies while they engage in comprehension of L2 input. These strategies have been defined as a series of principles that were posited in order to account for observations about L2 processing such as, (a) "learners are driven to get meaning while comprehending" (VanPatten, 2007, p. 116), (b) comprehension is cognitively demanding for learners, (c) learners are limited capacity language processors who cannot process the same amount of information as native speakers and (d) learners may make use of L1 processing strategies (VanPatten, 2007).

One particular principle, the First Noun Principle (VanPatten, 2004), has motivated a large amount of previous research and is relevant to the present study. This principle states that L2 learners tend to process the first noun they encounter in a sentence as the subject. This processing problem is especially prevalent for learners of Spanish when processing constructions that have non-canonical object-verb-subject word order. Consider examples (1) and (2), which respectively display the canonical word order (subject-verb-object) and the non-canonical word order (object-verb-subject) in Spanish.

(1) María besa a Juan

Maria$_{AG}$ kisses$_{-3RD-SG}$ Juan$_{PAT}$

'María kisses Juan'

(2) Lo besa María

him$_{-PAT-CL-3RD-SG-M}$ kisses$_{-3RD-SG}$ Maria$_{AGENT}$

'María kisses him'

VanPatten's model of Input Processing argues that L2 learners of Spanish are able to successfully process the types of sentences in (1). Whereas, learners would have difficulty processing sentences like (2). Under this model of input processing, this incorrect processing strategy is attributable to the First Noun Principle. That is, learners will assign the theta role of agent to the direct-object clitic pronoun rather than the theta role of theme and therefore incorrectly interpret the sentence as '*he kisses Maria'* rather than the correctly interpreting it as *'Maria kisses him'*.

Taking into consideration these L2 processing strategies, the instructional intervention Processing Instruction (PI) was devised as a way to guide learners to correctly process target forms that they would otherwise not process or process incorrectly (as described in the examples above). Creating an activity that follows the full PI paradigm consists of following the steps in (3) below (VanPatten, 2005).

(3) Steps for creating PI activities

(a) Give learners explicit information about a linguistic structure or form

(b) Inform learners about a particular processing strategy that may prevent correct processing of the linguistic structure/form during comprehension

(c) Structure input so that learners must correctly process the linguistic structure/form to get meaning and not only rely on natural processing strategies

Empirical studies have investigated the benefits of PI as compared to other methods of instruction—i.e., traditional instruction or meaningful output based instruction—as assessed by pretest-instructional treatment-posttest designs. Generally, the findings indicate that PI results in gains that are as large as or larger than other methods of instruction for both interpretation and production of target forms (see first section of Table 3, Benati, 2001; Benati, 2005; Cadierno, 1995; Farley, 2001a; Farley, 2001b; Morgan-Short & Bowden, 2006; VanPatten & Sanz, 1995; VanPatten & Cadierno, 1993a; VanPatten & Cadierno, 1993b). In addition to examining whether PI brings about L2 development various researchers have tried to tease apart which aspects of PI are responsible for said development (see second section of Table 3, Benati, 2004; Farley, 2004; Sanz & Morgan-Short, 2004; VanPatten & Oikkenon, 1996; Wong, 2004), bringing into question the necessity of explicit information provided to learners. These researchers have posited that explicit information may not be a necessary part of PI but that gains are actually due to structured input practice (the component defined in example 3c). Results from this strand of research support the claim that, at least for some linguistic structures, explicit information is not necessary for development to take place. That is, structured input practice appears to be the crucial component of PI. However, it is important to note that the majority of these studies have also relied on a pretest-instructional treatment-posttest design, thus they are unable to speak directly to performance during structured input practice, i.e., when learning is assumed to take place.

Table 3

Summary of Processing Instruction Studies

Study	N	Proficiency level	Linguistic feature	Input Processing Principle	Experimental groups	Assessment tasks	Results
VanPatten and Cadierno (1993b)	80	2nd year university Spanish	Spanish DO pronouns	First Noun Principle	PI TI C	Interpretation Production Sentence-level completion	PI > TI and C PI and TI > C
VanPatten and Cadierno (1993a)	49	2nd year university Spanish	Spanish DO pronouns	First Noun Principle	PI TI C	Interpretation Production Sentence-level completion	PI > and C TI > C
Cadierno (1995)	61	3rd semester university Spanish	Spanish past tense	Lexical Preference Principle	PI TI C	Interpretation Production Sentence-level completion	PI > TI and C PI and TI > C
VanPatten and Sanz (1995)	44	3rd semester university Spanish	Spanish DO pronouns	First Noun Principle	PI C	Interpretation Production Written and oral sentence-level completion Video narration Structured Interview	PI > C PI > C PI = C PI > C

Benati (2001)	39	2nd semester university Italian	Italian Future	Lexical Preference Principle	PI Output C	Interpretation Production Written verb conjugation Oral sentence-level	PI > output > C PI and output > C
Farley (2001a)	29	4th semester university Spanish	Spanish subjunctive	Lexical Preference Principle	PI MOI	Interpretation Production Sentence-level completion	PI > MOI PI = MOI
Farley (2001b)	50	4th semester university Spanish	Spanish subjunctive	Lexical Preference Principle	PI MOI	Interpretation Production Sentence-level completion	PI = MOI PI = MOI
Benati (2005)	77	Secondary school English	English simple past tense		PI MOI TI	Interpretation Production Sentence-level completion	PI > MOI and TI PI = MOI = TI
Morgan-Short and Wood-Bowden (2006)	45	1st semester university Spanish	Spanish DO pronouns	First Noun Principle	PI MOI C	Interpretation Production Sentence-level completion	PI and MOI > C MOI > C
Investigations on the role of explicit information in Processing Instruction							
VanPatten and Oikkenon (1996)	59	2nd year university Spanish	Spanish DO pronouns	First Noun Principle	PI EI SI	Interpretation Production Sentence-level completion	PI = SI > EI PI > EI; PI = SI; SI = EI

Benati (2004)	38	2nd semester university Italian	Italian future	Lexical Preference Principle	PI EI SI	Interpretation Production Sentence-level completion	PI = SI > EI PI = SI > EI
Farley (2004)	54	4th semester university Spanish	Spanish subjunctive	Lexical Preference Principle	PI SI	Interpretation Production Sentence-level completion	PI > SI PI > SI
Wong (2004)	94	1st quarter university French	French negation	Lexical Preference Principle	PI EI SI C	Interpretation Production Sentence-level completion	PI = SI > EI & C PI = SI > C PI > EI; SI = EI EI = C
Sanz and Morgan-Short (2004)	69	1st and 2nd year university Spanish	Spanish DO pronouns	First Noun Principle	+EI/+F -EI/+F +EI/-F -EI/-F	Interpretation Production Sentence-level completion Supra-sentential level written elicitation	+EI = -EI; +F = -F +EI = -EI; +F = -F +EI = -EI; +F = -F

Investigations into the role of explicit information in Processing Instruction that have employed concurrent measures							
Fernandez (2008)	84	3rd semester university Spanish	Spanish DO pronouns	First Noun Principle	PI SI	Trials to criterion Response time Interpretation	PI = SI PI = SI PI = SI
Fernandez (2008)	84	3rd semester university Spanish	Spanish subjunctive	Lexical Preference Principle	PI SI	Trials to criterion Response time Interpretation	PI < SI[a] PI < SI PI > SI
Henry et al. (2009)	38	3rd semester university German	German OVS word order	First Noun Principle	PI SI	Trials to criterion	PI < SI
VanPatten and Borst (2012)	46	3rd semester university German	German OVS word order	First Noun Principle	PI SI	Trials to criterion	PI < SI

Note. The table is divided into three sections: (1) PI studies versus some other instructional method; (2) Investigations into the role of explicit information in PI; (3) Investigations into the role of explicit information that have used concurrent measures. PI = Processing Instruction group; TI = Traditional Instruction group; C = Control group; Output = Output Practice group; MOI = Meaningful Output Instruction group; EI = Explicit information only group; SI = Structured Input only group; C = Control group; F = Feedback during practice group; [a]These studies employed a trials-to-criterion method of scoring, thus results such as PI < SI indicate that the PI groups reached criterion sooner (in a smaller number of trials) than SI groups.

Although it is standard within this line of research to employ non-concurrent measures of learning, in recent years various researchers interested in assessing the role of explicit information in PI have begun to employ trials-to-criterion as a concurrent measure of processing (see section 3 of Table 3, Fernandez, 2008; Henry, Culman, & VanPatten, 2009; VanPatten & Borst, 2012). Trials-to-criterion is an experimental design that monitors participants' responses on each trial of structured input practice. This practice typically consists of an image-sentence matching activity. On each trial, participants hear a sentence in the L2 while viewing two contrasting images and are asked to select which image best depicts the sentence. Crucially, in order for participants to make their decision they must correctly process the target structure in the sentence. That is, the two contrasting images will differ based on the target structure. Once a participant correctly responds to a pre-specified number of consecutive trials they are assumed to be correctly processing the linguistic target, and thus have reached criterion. Therefore, this method of assessing processing during practice provides information related to the relative speed of acquisition of correct processing strategies of linguistic target forms (operationalized as number of trials) when explicit information is provided and when it is not.

Results from these studies generally indicate that participants who received explicit information about the target structure reach criterion before those who did not receive explicit information. However, this effect appears to be dependent on the linguistic structure investigated. That is, for Spanish direct-object pronouns, the provision of explicit information did not result in a facilitative effect, such that both groups on average needed the same number of trials to reach criterion (Fernandez, 2008). However, when the target structure was Spanish subjunctive (Fernandez, 2008) or OVS word order in German (Henry

et al., 2009; VanPatten & Borst, 2012) a positive effect for explicit information was found, such that participants that received the explicit information reached criterion after fewer trials than those who did not receive explicit information.

In sum, PI has had a productive history in the field of L2 acquisition, prompting various strands of empirical research within a PI framework. Overall, the findings indicate that although PI provides benefits as compared to other methods of instruction, these benefits may be due to structured input (SI) practice alone, rather than the full PI paradigm, at least for some linguistic structures. However, it is important to note that the majority of these findings rely on a pretest-instructional treatment-posttest design, which does not allow for concurrent monitoring of participant processing during practice. Therefore, although it is assumed that attention to target form is increased as a result of PI or SI practice, no direct evidence for this claim is available from the current literature.

Thus, the incorporation of SI practice within the current study is motivated by the following: First, SI practice is the manipulation of attention through task demands and therefore can provide insight into the open question of whether attention to form leads to learning of that form. Second, based on previous research, it is apparent that task-essential—i.e., in order to complete the task learners must correctly interpret the target form— SI practice drives L2 development within a PI paradigm. However, current research has mainly relied on offline measurements of learning, that is, these studies have attributed development to full PI or SI without actually assessing learner processing while they interact with the L2. Therefore the use of SI within an experimental design that will include a concurrent measure of learner attention and processing provides insights into whether and how learners change their processing strategies due to SI practice. This will provide

direct evidence for the benefits that have been associated with SI practice and PI more generally.

2.4.3 Interim Summary: Indirect Evidence From Instructed Second Language Research

In sum, instructional interventions such as IE and SI practice have been developed on the premise that manipulations of attention causing learners to attend to specific linguistic forms will result in development of those forms. Although results from the empirical investigations within this line of research appear to support this assumption in that L2 development is evidenced for PI (e.g., Farley, 2001b) as well as for some IE paradigms (e.g., Lee & Huang, 2008), these results mainly rely on non-concurrent measures of attention and thus have not established that L2 developmental gains are due to attention having been manipulated by the instructional intervention. Only one study has directly shown that attention is directed to a linguistic target form during interaction with that form under one of these instructional interventions (IE), and yet, in this study attention was not related to development of the form (Winke, 2013). Therefore, more research is needed in order to fully assess the role of attention while learners interact with these both IE and SI practice. A concurrent measure of attention, such as eye-tracking, would provide novel evidence of whether attention is manipulated by these instructional interventions and if these manipulations of attention can account for learning.

2.5 Interim Summary: Attention in Second Language Literature

There are various models that include attention as a key construct. However, it is important to note that although these models have produced empirical investigations, the majority of those investigations have attempted to address questions

related to learning without *awareness* rather than more fully investigating the role of attention during learning. Additionally, those studies that do specifically address the effects of attention on learning are limited either methodologically or in their scope of inquiry. That is, in terms of methodological limitations these studies have either employed non-concurrent measures of attention, or think-aloud protocols. Furthermore, the studies that have employed a concurrent measure such as eye-tracking (Godfroid et al., 2013; Godfroid et al., 2010; Godfroid & Schmidtke, 2013) have only looked at lexical development, with only one study examining an L2 grammatical development through (Godfroid & Uggen, 2013).

In addition, instructional interventions have been created on the premise that manipulating learner attention so that learners allocate their attention to specific forms will promote linguistic development. However, research within the frameworks of IE and PI only provide indirect evidence for the role of attention considering that the majority of this work has employed non-concurrent measures employing a pre-test-instructional intervention-post-test design to assess attention. Thus, based on the available data in the L2 literature, the following questions are still open for investigation:

(a) Does attention to a target form result in learning of that target form?

(b) More specifically, does attention to rule-based grammatical features result in learning of those features?

(c) Does textual input enhancement lead learners to allocate attention to target forms?

(d) Does structured input practice lead learners to allocate attention to target forms?

In order to answer these open questions related to attention it is necessary to explore the extant literature on the construct of attention from cognitive science. This large body of literature offers various theories and models of attention as well as methodological approaches that allow for the concurrent assessment of attention during the completion of a task. In the following sections, I will briefly outline some of the major theories from cognitive science that have informed current assumptions and perspectives about attention (§ 2.6) and then discuss those assumptions (§ 2.7). In § 2.8, I will present a current model of attention that will be adopted in the present project. Finally, I will explain how theoretical and methodological approaches from cognitive science can be adopted to answer questions about L2 acquisition and present the research questions for the present study (§ 2.9).

2.6 Perspectives on Attention From Cognitive Science

The construct of attention has been investigated within the field of cognitive science from various perspectives dating back as early as 1890 (James, 1890). Over the years, cognitive psychology has approached the construct of attention from various theoretical perspectives all of which have aimed to describe the basic properties of attention. Some of the prominent models will be discussed below.

2.6.1 Theory From Cognitive Psychology

Broadbent (1958; 1982) first proposed the metaphor of a filter for the attentional system. This approach emerged from experimental work conducted in applied contexts. One such example is the analysis of the work of air traffic controllers communicating with various airplanes at the same time (Broadbent, 1982). The results suggested that temporal overlap in incoming messages caused interference. As a way of explaining this interference,

the attentional system was conceptualized as a three-component model that contained (a) a limited capacity P-system (P-system), (b) a filter, and (c) a short-term memory system (STM). The P-system was thought of as a channel that could only handle a limited amount of information. The filter and the STM both served to protect the limited capacity P-system from becoming overloaded. Information in the STM was posited to be held in a buffer state and initially encoded for surface features. The filter suppressed unwanted information that was fed to it from the STM and allowed important information to pass through to the P-system.

Filter theory contributed foundational theory to the field of attention and resulted in a large amount of empirical work on the construct of attention and its limited capacity nature. However, as this empirical research emerged, it became clear that temporal overlap of any two signals was not the sole cause of interference but rather, specific types of signals interfered with one another. Evidence for this perspective came from studies that found that tasks that included auditory verbal input interfered with verbal outputs, e.g., speaking, and tasks that included visual imagery as input interfered with spatial outputs, e.g., pointing (Allport, Antonis, & Reynolds, 1972; Brooks, 1968).

Based on this research, a new way of conceptualizing the attentional system was proposed. Rather than explain the limited capacity of attention as an inherent characteristic of the processing stream, as was the case in Filter Theory, new models, referred to as Multiple Resource Theories, proposed specific limited capacity resource pools to account for different types of interference. For example, Wickens' model (1980; 1984; 2002) posited that in order for a participant to complete a task, they draw on resources that are distributed across four distinct dimensions of cognitive operations

related to: (a) modality, (b) type of code, (c) processing stage, and (d) type of visual processing. Thus, under this perspective dual-task interference is a result of tasks that draw on resources from the same dimension. Consequently, the limited nature of attentional resources is specific to a given task and the type of resource being tapped rather than being a temporal based characteristic of attention.

In addition to theorizing about the limited capacity nature of attention, the fact that attention appeared to be selective was also considered a key part of major theories of attention in cognitive psychology (Neumann, 1996). Selectivity served as a way of explaining how the human processer could cope with abundant information in the input given its limited capacity nature. That is, information that is important is selected from among the competing information in the input in the environment. The selective nature of the human attentional system is a key component of both Filter and Multiple Resource Theories of attention (Broadbent, 1958; 1982; Neumann, 1996; Wickens, 1980; 1984; 2002). Researchers became interested in exploring this selective component of attention and better understanding how it operated. This line of research manifested itself in various ways—one issue that is still open for debate within theories about attention is when selection and integration of information take place. One example of this line of research dealt specifically with when selection takes place during processing. With one perspective arguing that selection takes place early in attentional processing (Deutsch & Deutsch, 1963), that is once stimuli are processed at a superficial or perceptual level, they are deemed important and selected for further more profound processing. However, there is also evidence that selection occurs rather late (Treisman, 1964), allowing for the identification of objects at a more profound level (i.e., extracting semantic information from

a word) before selection—i.e., before the stimuli is thought to be fully processed and retained in memory.

In addition to the theories and research mentioned above, other researchers began to identify and theorize about specific aspects of human attention, which lead to the increasingly specialized, yet vast body of literature on attention in cognitive science. That is, specific aspects, components and types of attention were identified and subsequently became separate topics of research. For instance, specialized research in the topic areas of selective attention (e.g., Treisman, 1964) sustained attention (e.g, Koelega, 1996), perceptual attention (e.g., Lavie et al., 2004), auditory attention (e.g., Ten Hoopen, 1996), visual attention (e.g., Van der Heijden, 1996), information processing (e.g., Underwood & Everatt, 1996), and action planning (e.g., Fagioli, Hommel, & Schubotz, 2007) among other areas all emerged as part of the present body of literature on attention in cognitive science. Much of this work relied on the use of reaction time data. However, research on visual attention began to employ eye-tracking as a measure of attention in various types of complex tasks, such as reading (e.g., Ferreira & Clifton Jr, 1986; Raney & Rayner, 1995), and scene perception (Henderson, 2003).

2.7 Basic Assumptions From Cognitive Science

The above-mentioned theories and perspectives served as the basis for the specialized work on attention within the field of cognitive psychology. Across these varying subfields of research on attention there are various assumptions and generalizations about attention that can be made. In the following sub-sections, I will discuss some of the basic characteristics of attention that have emerged from the research on attention in cognitive psychology.

2.7.1 Attention Is Limited

Across the various theories of attention that have been established throughout the years, the primary defining characteristic of attention is that it is *limited*. Evidence for this characteristic comes from dual-task interference in real-world situations and has been mirrored in experimental paradigms that employ dual tasks. Under a single-channel theory of attention, such as Filter Theory, these experimental paradigms require participants to complete two tasks simultaneously. Participant performance on the two tasks is then compared to trials where they only had to complete one of the two tasks. Thus, any degradation in performance (i.e., reaction time or accuracy) is a result of being unable to attend to both sets of task demands at once. On the other hand, under multi-channel theories, such as Wickens' (1980; 1984; 2002), attention can be allocated to the two concurrent tasks in a graded manner (Neumann, 1996). However, specific tasks will cause more interference than others.

2.7.2 Attention Is Selective

Another hallmark of attention that has emerged as a way of explaining how the human processor deals with limited attentional resources is the idea that attention is *selective*. The selective nature of attention was initially investigated through auditory paradigms with the use of dichotic listening tasks. That is, tasks where different auditory messages are presented to each ear (Cherry, 1953; Moray, 1959). Subsequently, selective visual attention was investigated with visual search paradigms, employing eye-movements as assessments of attention (Desimone & Duncan, 1995; Sanders & Donk, 1996). In these tasks, participants are required to search for a specific stimulus on a display containing distractor stimuli. Results from these studies indicate that specific criteria, such as auditory

pitch or visual location, dictate what will be selected from the input. Selected stimuli are then processed and retained in memory whereas non-selected stimuli may be processed superficially but not retained in memory.

2.7.3 Attention and Awareness Are Related

The relationship between attention and awareness has been explored within cognitive science and it is generally assumed that attention controls access to awareness (Baars, 1997; Eriksen & James, 1986; Posner, 1994; Posner & Petersen, 1990). However, recent research has aimed to shed further light on this relationship and has shown that although attention and awareness may be related they are separable during the completion of certain types of dual-tasks (Koch & Tsuchiya, 2007; Koch & Tsuchiya, 2012). Specifically, evidence from dual-task paradigms indicates that participants can "become conscious of an isolated object or the gist of a scene despite the near absence of top-down attention," (Koch and Tsuchiya, 2007, p. 16). That is, awareness of specific aspects of the environment is attainable without explicitly attending to those aspects. Conversely, evidence from dual tasks also suggests that participants can "attend to specific locations for several seconds and yet fail to see one or more attributes of an object at that location" (Koch and Tsuchiya, 2007, p. 17). In other words, in some cases, attention may be allocated to specific piece of information, but that does not result in conscious awareness of that information. Thus, the two mechanisms are related, and in some cases attention to specific information facilitates awareness but in other cases there is dissociation between the two mechanisms.

2.7.4 Attention Is Necessary for Learning

An additional crucial assumption that comes from cognitive psychology is the general assumption that attention is essential for learning (Baars, 1993; Carlson & Dulany,

1985; Fisk & Schneider, 1984; Logan, 1988; Nissen & Bullemer, 1987; Shiffrin & Schneider, 1977; Velmans, 1991). This claim has also been made within various lines of research that are particularly interested in different types of learning tasks such as associative learning, and category learning.

In the associative learning literature, which investigates how associations between responses to stimuli and outcomes of those responses are learned, the prominent competing theories rely on attention as the mechanism that drives learning. For example Mackintosh's model (1975) claims that learning takes place as a result of paying attention to stimuli that result in a predictable outcome (i.e., reinforcement) during a learning task (Pearce & Mackintosh, 2010) and thus the association between the stimulus and reinforcement will be learned as a result of attention. On the other hand, Pearce and Hall's model (Pearce & Hall, 1980) claims the opposite. That is, more attention will be paid to a stimulus that has an unexpected outcome, as compared to a stimulus that has a predictable outcome. Therefore learning of the association between a stimulus and its outcome takes place as a result of the attention paid to the unexpected outcome, rather than the predictable outcome. Although these two models have been described in the literature as stark opposites, it is clear that attention is a key construct in both of them (Pearce & Mackintosh, 2010).

Similar trends can be found within category learning research. This line of research aims to answer questions about strategies employed when attempting to categorize objects. Selective attention is a key construct in the major theories of category learning, such as in exemplar models (Medin & Schaffer, 1978; Nosofsky, 1988), where categorization is decided based on similarity to memory traces of previously categorized

objects, and in prototype models of category learning (Smith & Minda, 1998), where categorization is decided based on similarity to a prototypical representation of the object. Attention to specific characteristics of an object will lead to either stronger memory traces in the exemplar model or more accurate comparisons to prototypical representations under the prototype model (Rehder & Hoffman, 2005b). Thus, under both of these models attention is a key mechanism that promotes the learning of categories.

2.7.5 Eye-Movements Index Attention

Finally, an important assumption about attention from cognitive science is that eye-movements can serve as an index of overt attention (Deubel, Schneider, & Bridgeman, 1996; Rayner, 1998; 2009). Empirical work in cognitive psychology has provided evidence for a tight coupling of eye-movements and attention (Kowler, Anderson, Dosher, & Blaser, 1995). More specifically, a covert shift in attention (i.e., mental focus) precedes an overt shift in attention (i.e., eye-movements). It is important to note that in simple discrimination tasks covert attention can be directed to aspects of stimuli without the typical accompanying shifts in eye-movements. However, in most complex tasks, such as reading, shifts in covert attention are thought to reliably lead to shifts in eye-movements (Rayner, 1998). Thus, we can employ eye-tracking as a way to measure overt attention during language processing.

2.8 External and Internal Attention

Although there has been a fair amount of investigation into the construct of attention, there are still open questions and unresolved issues in terms of how best to conceptualize and operationalize this construct. Based on the fact that attention appears to be an important aspect of various cognitive processes recent theories of attention argue

that attention cannot be narrowly defined as a part of one particular cognitive operation (Chun et al., 2011). This is based on the fact that attention affects visual processing, auditory processing, motor control, and action planning, among other cognitive operations.

Another issue related to attention research in cognitive science is that there is an abundance of theories and metaphors in current research used to describe various aspects of attention within the field of cognitive psychology (Chun et al., 2011; Raz & Buhle, 2006). Furthermore, in many cases these theories aim to account for specific aspects or types of attention, rather than try to describe attention as a unified construct. In many cases, these theories do not reference one another, therefore making it difficult for researchers to make conclusions across theories. These issues related to attention research in cognitive psychology make the adaptation of models of attention to L2 research difficult to implement.

As a way of mitigating the abundance of specialized research and in order to create a framework through which various theories can come together to explain results of empirical work from cognitive psychology, Chun et al. (2011) proposed a taxonomy of attention based on how attention is manipulated. This is a novel approach that aims to synthesize findings from various sub-fields within the large body of research about attention.

Based on a survey of findings in the attention literature, Chun et al. proposed that attentional mechanisms can be grouped as either external or internal. Under this perspective external attention refers to those mechanisms that are manipulated by externally generated cues or signals (also referred to as exogenous cues or signals). Externally generated cues are thought to mainly affect perceptual processing, and thus can

vary based on modality. For instance, a loud or unexpected noise would affect the external attentional system through auditory channels. With regard to visual attention, augmenting the saliency of a specific feature of an object in the visual field will manipulate external attention—e.g., changing the brightness of an image, or the color of a word. Conversely, internal attention refers to those mechanisms that are affected by internally generated information (also referred to as endogenous information). Internally generated information is information that an individual derives: (a) from the demands of a task, (b) as a result of decision-making, or (c) based on the contents of working memory. Additionally, this type of information is typically thought to be employed in goal-directed processing.

This proposal, which advocates for a distinction between external and internal attentional mechanisms, is supported by a double dissociation found in the surveyed empirical literature. Research has shown that dual-tasks that consist of external and internal manipulations of attention do not interfere with one another and thus do not pose a processing burden for participants. Pashler (1991; 1994) found that none of the following manipulations of internal attentional mechanisms affected perceptual processing tasks (i.e., tasks that recruit external attentional mechanisms): demands on working memory, response selection or task switching paradigms. On the other hand, Lavie et al. (2004) conducted a series of experiments that demonstrated that distractors interfered more during a selective attention task, thought to recruit internal attentional mechanisms, when paired with dual-task condition where *internal attention* was taxed, through a high-working memory load, as compared to a dual-task condition where external attention was taxed (through a higher perceptual processing load). This pattern of results suggests that although these attentional mechanisms can collaborate, the internal attentional system and

the external attention system are separable to some degree.

This distinction of external and internal attention not only allows researchers to synthesize findings from various areas of attention research but also allows these concepts to be adapted to areas of research outside of cognitive science, such as the field of L2 acquisition. In the following section, I apply this distinction of external and internal attention and the types of manipulations thought to tap into these mechanisms to L2 acquisition in an attempt to elucidate the relationship between attention and learning an L2.

2.9 Merging Cognitive Science and Second Language Acquisition Views of Attention

As previously stated, attention is assumed to be necessary for learning in L2 acquisition research, however scant direct empirical evidence supports this claim. Thus, by incorporating theory and methodology from cognitive psychology, we can further examine the role of attention and make concrete claims about attention and L2 development. Operationalizing attention based on the taxonomy of external and internal attention proposed by Chun et al. may be particularly fruitful as opposed to the three-tiered attentional network (Posner & Petersen, 1990; Tomlin & Villa, 1994) for various reasons. First, the external/internal distinction will avoid the ever-present problem of operationalizing each of the attentional mechanisms in the three-tiered network (Simard & Wond, 2001). Second, and perhaps more importantly, two different testable questions may be posed—Is L2 development affected by external manipulations of attention? And is L2 development affected by internal manipulations of attention? More specifically, in order to more fully understand the role of attention in L2 development, we can examine the

learning outcomes related to manipulating external versus internal attention. Fortuitously, the instructional interventions previously reviewed seem to map onto the external and internal manipulations proposed in cognitive science. To remind the reader, I have focused on two instructional interventions Input Enhancement (IE) and Processing Instruction—specifically, Structured Input (SI). Based on the definition of IE, this instructional intervention affects the external attentional system through the augmentation of saliency of external visual linguistic stimuli. Conversely, the presentation of SI affects the internal attentional system by manipulating the demands of tasks that require responses to linguistic stimuli, and therefore manipulates internally generated information.

In addition to adopting a model of attention from cognitive science in the current study, I have also adopted the robust concurrent method of eye-tracking from cognitive science. The use of this methodology will allow for attention to be directly measured as participants interact with these instructional interventions. Consequently, a prominent methodological limitation—i.e., the lack of a reliable concurrent measure—present in much of the L2 research described in this chapter can be addressed by incorporating the use of eye-tracking in the proposed study. Eye-tracking has been used to investigate various cognitive functions, including (a) *reading* (Ferreira & Clifton Jr, 1986; Pickering & Frisson, 2001; Raney & Rayner, 1995), (b) *language comprehension* (Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995) and (c) *production* (Griffin & Bock, 2000), (d) *scene perception* (Henderson, 2003), and (e) *problem solving* (Grant & Spivey, 2003). Moreover, and most importantly, this method has been used to measure attention (Deubel et al., 1996; Rayner, Pollatsek, Ashby, & Clifton Jr, 2012; Rayner, 1998; Rayner, 2009) and therefore is well suited to address the primary research questions of this project, which will be discussed in

the following section.

2.10 Aims, Research Questions and Hypotheses

The study aimed to address the more global claim in L2 acquisition that attention to form leads to linguistic development of those forms. The project addresses this by examining the effects of external and internal manipulations of attention on the development of a novel morphosyntactic target form. The study provides a direct measure of overt attentional allocation during practice with the target form through the use of eye-tracking as a concurrent measure of attention.

Second, the study aims to probe further into the construct of attention in L2 acquisition by examining how L2 development is affected by the separable external and internal attentional systems, as motivated by a current cognitive science theory of attention (Chun et al., 2011). In the present study, the implementation of manipulations that should tap into the two attentional systems in a language-learning paradigm takes the form of Input Enhancement (external) and Structured Input Practice (internal). While it has been established that the attentional manipulations tap into separable attentional processes, it should also be noted here, that these instructional interventions and their implementation in the present study are inherently different from one another and thus cannot be directly compared in a quantitative way (as will be discussed further in Chapter 3).

2.10.1 Research Questions

This study addresses critical theoretical questions about adult-learned L2 as informed by methodological approaches and theoretical perspectives from cognitive science through two sets of parallel research questions that can be divided based on the type of attentional manipulation employed and consequently the type of attentional

mechanisms that are affected. First, regarding the external manipulation of attention:

RQ1A: Do instructional interventions that involve an **external manipulation of** attention lead learners to allocate overt **attention** to a novel linguistic target form?

RQ1B: Do instructional interventions that involve an **external** manipulation of attention bring about **learning** of a novel linguistic target form?

RQ1C: Does overt **attention** directed to a novel linguistic target form by an **external** manipulation of attention account for **learning** of that form?

Next, with regard to the internal manipulation of attention:

RQ2A: Do instructional interventions that involve an **internal** manipulation of attention lead learners to allocate overt **attention** to a novel linguistic target form?

RQ2B: Do instructional interventions that involve an **internal** manipulation of attention bring about **learning** of a novel linguistic target form?

RQ2C: Does overt **attention** directed to a novel linguistic target form by an **internal** manipulation of attention account for **learning** of that form?

2.10.2 Hypotheses

With regard to RQ1A, based on the findings from Winke (2013) that attention was directed to enhanced target forms, an external manipulation of attention similar to the one employed in the present study, I predict similar findings:

H1A: The external manipulation of attention employed in the present study, Input Enhancement, will affect attentional allocation and lead learners to allocate overt attention to a novel linguistic target form.

Regarding RQ1B**,** based on the claim that attention leads to linguistic development, I predict a positive effect for the external manipulation of attention employed in the current study, Input Enhancement. Note, however, although mixed results of research investigating the effects of Input Enhancement (Han et al., 2008; Lee & Huang, 2008) have been evidenced, the present study will be the first to embed enhanced input within a language practice task rather than a passive reading passage and thus should contribute unique insight into the effectiveness of this instructional intervention with regard to linguistic development. In sum, I hypothesize the following:

H1B: The external manipulation of attention employed in the present study, Input Enhancement, will result in linguistic development of the target form.

With respect to RQ1C, given that I have predicted an effect for attentional allocation, as well as an effect for learning, I predict that this external manipulation of attention will account for learning of the target form. Furthermore, as the type of task and the learning assessments are different than those employed in Winke (2013), it is not expected that the results will mirror those found in Winke (i.e., no relationship between attention as measured by eye-tracking and learning). Thus, the following prediction is made:

H1C: The external manipulation of attention employed in the present study, Input Enhancement, will account for linguistic development of the target form.

Concerning RQ2A, given the popular claim that attention to forms leads to linguistic development of those forms and the fact that L2 research on the effectiveness of structured input practice has shown a positive effect for linguistic development (e.g., Benati, 2004; Farley, 2004; Wong, 2004), I predict that the internal manipulation employed in the current study, implemented as structured input practice, will have an effect on attentional

allocation. Thus, the results of the present study should contribute novel insight into the cognitive processes of learners as they interact with structured input practice and therefore, the following prediction is made:

H2A: The internal manipulation of attention employed in the present study, structured input practice, will affect attentional allocation and lead learners to allocate overt attention to a novel linguistic target form.

With regard to RQ2B**,** given the positive effects of PI (e.g., Farley, 2001a; Farley, 2001b; Morgan-Short & Bowden, 2006; VanPatten & Cadierno, 1993a; VanPatten & Cadierno, 1993b) and particularly the positive effects associated with structured input practice (e.g., Benati, 2004; Farley, 2004; Wong, 2004), I predict a positive effect with regard to learning for the internal manipulation of attention. The present study is expected to add to the body of research supporting structured input practice as a crucial part of PI and as an instructional intervention that brings about morphosyntactic development. Thus, in line with previous research, I predict:

H2B: The internal manipulation of attention employed in the present study, structured input practice, will result in linguistic development of the target form.

Regarding RQ2C As structured input practice has been shown to have positive effects on learning, as mentioned above, and I have predicted that this internal manipulation of attention will lead to overt attentional allocation to the target form, I predict that this internal manipulation of attention will account for learning. Results from this research question should add a new layer of evidence in support of structured input practice and its benefits on linguistic development. That said, I hypothesize the following:

H2C: The internal manipulation of attention employed in the present study, structured input practice, will account for linguistic development of the novel target form.

Regardless of the direction of the findings for either set of research questions the results of the present study will contribute to the field of L2 acquisition research by providing direct empirical evidence for the role of attention in morphosyntactic development and extending previous research that has addressed this question with regard to vocabulary development and morphological development (Godfroid et al., 2013; Godfroid et al., 2010; Godfroid & Schmidtke, 2013; Godfroid & Uggen, 2013). Furthermore, the results are expected to provide insight into the cognitive processes that learners employ while they interact with instructional interventions that employ an external manipulation of attention (i.e., Input Enhancement) and instructional interventions that employ an internal manipulation of attention (structured input practice). Thus, this project extends the research surrounding these two instructional interventions by providing direct concurrent measures of how overt attention is affected while learners interact with these interventions. This type of evidence is crucial for better understanding how and when to utilize these interventions in language classrooms and in the design of pedagogical materials. Lastly, the results are expected to contribute to the field of cognitive psychology by extending the taxonomy of external and internal attentional mechanisms (Chun et al., 2011) and the type of manipulations that tap into these mechanisms (e.g., Lavie et al., 2004; Pashler, 1991; Pashler, 1994) to a language-learning paradigm.

3. RESEARCH METHODS AND DESIGN

3.1 Introduction

The present study examined how the development of L2 morphosyntactic structures was affected under external and internal manipulations of attention designed to promote learning. The experimental design consisted of 3 experimental conditions to which novice learners of Spanish as an L2 were randomly assigned: the external attentional condition, the internal attentional condition and the control condition. In all conditions, participants completed a series of picture-sentence matching tasks, where they had to choose a picture (from a pair) that best depicted stimuli sentences containing a Spanish direct-object pronoun. Participants that completed either the external or internal attentional conditions completed this picture-sentence matching task while their attention was manipulated either through external cues or internal cues via the use of input enhancement (IE) or structured input (SI) practice, respectively. Participants in the control condition completed a similar task with the same number of items as the participants in the two experimental conditions, however their attention was not manipulated in any way during this practice, thus ensuring that any effects found for either of the experimental conditions were not due solely to exposure to the target form, but rather due to the experimental manipulations themselves.

Importantly, the amount of attention allocated to the L2 target form in each experimental condition and the control condition was measured by recording participant eye-movements. In order to ascertain whether attention was affected by these manipulations (or not in the case of the control condition) the eye-movement record obtained during an *experimental block* of trials (which consisted of either the external or

internal manipulation of attention, or no manipulation was employed depending on the condition) was compared to a *within-subjects baseline block* of trials, which always preceded the experimental block. This within-subjects baseline block provided a measure of how participants allocated their attention naturally, without any sort of instructional manipulation and serves as a crucial within-subjects point of comparison for assessing whether the external and internal conditions lead learners to direct their attention to the target form. Linguistic developmental gains on the target form were assessed with an interpretation test. These different conditions and the distribution of the different blocks of trials (within-subjects baseline block, experimental blocks) are displayed in a graphic representation in Figure 2. All of these conditions were programmed in Experiment Builder (SR-Research) and were self-paced (i.e., the participant moved through the experiment by pressing a designated button on a game controller), in order to promote as natural as possible reading and processing of their L2.

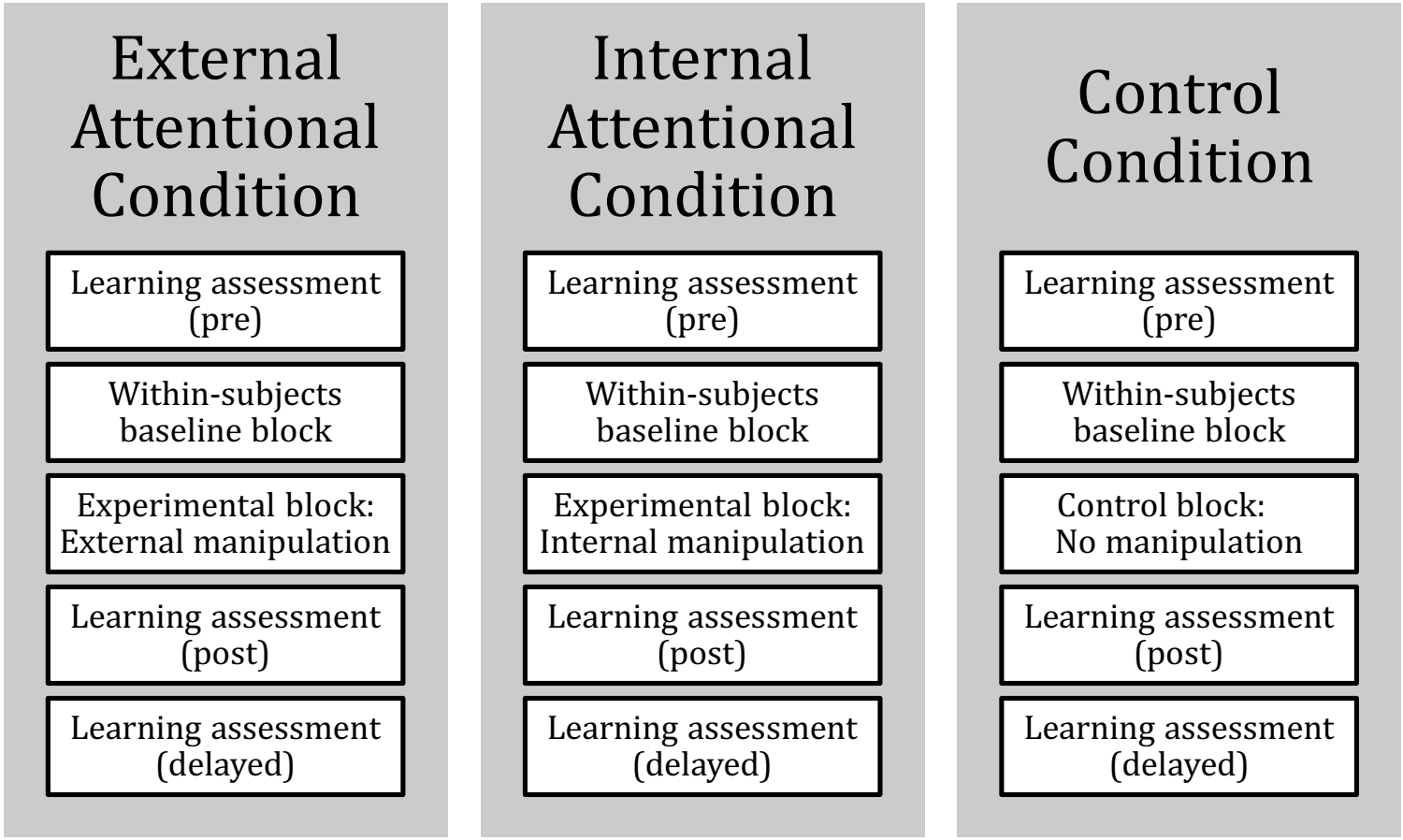

Figure 2. Schematic of experimental design. Each of the larger outer rectangles represents one of the three conditions participants were randomly assigned to complete (External Attentional Condition, Internal Attentional Condition and Control Condition). Each of the smaller rectangles represents the tasks (learning assessments) and the blocks of trials that each participant completed in each condition.

In the following sections, I will more fully describe the participants recruited for this project (§ 3.2), and the stimuli sentences (§ 3.3) that were used in the experimental materials (§ 3.4). These materials consisted of the within-subjects baseline block of trials (§ 3.4.1), the experimental blocks that participants completed (§ 3.4.2) and the learning assessment (§ 3.4.3). Next, I will describe the overall procedure of the experimental testing sessions (§ 3.5) and the scoring and analysis of the data (§ 3.6).

3.2 Participants

Fifty-five novice L2 learners of Spanish who were unfamiliar with the target form and who had normal-to-corrected vision participated in this study. The average participant age was approximately 21 years, and the group consisted of 32 females and 23 males. Participants were recruited from first-semester Spanish courses at the university level and participated in the study before being exposed to the target form in their class (i.e., before the 15th week of the semester). On average participants reported beginning learning Spanish as adults, with a mean age of exposure of approximately 18 years (*SD* = 4.61 years). In order to control previous exposure to the target form in Spanish or to similar forms in other Romance languages, participants were pre-screened over the phone and determined to not have studied Spanish or any other Romance language for more than one year (average study of Spanish was just under half a year). Additional language use and background information was collected from participants including information about (a) number of years of previous experience with Spanish, (b) number of other known languages, (c) number of hours per week spent using Spanish outside of class. Results from independent samples t-tests confirmed that no differences existed between the control group and either of the experimental groups with regard to the factors outlined above (see

Table 4 for group means of the language background and use variables and results from independent samples t-tests comparing each experimental group to the control group).

Furthermore, based on previous PI research (Sanz & Morgan-Short, 2004), as an additional way of eliminating participants who had prior experience with the target structure, participants were excluded from the final analysis if they demonstrated above 60% accuracy with the target form on a pre-test. Five participants were excluded as a result of exceeding this threshold and their data is not represented in the participant characteristics described above. Results from an independent samples t-test confirmed that no differences existed between the control group and either experimental group with regard to accuracy on the pre-test (again, see Table 4 for means and results from independent samples t-test).

Table 4

Participant Background and Language Use Characteristics

Group	n	Years of Experience with Spanish		Age of Exposure to Spanish		Hours/Week Using Spanish Outside of Class		Age		Accuracy on Pre-test		Number of Additional Languages Known	
		M (SD)	*p*	*M (SD)*	*p*	*M (SD)*	*p*	*M (SD)*	*p*	*M (SD)*	*p*	*M (SD)*	*p*
Control	14	.35 (.59)		18.64 (5.35)		.36 (.48)		20.79 (4.87)		.31 (.17)		.86 (.86)	
External	21	.43 (.60)	.69	17.85 (3.9)	.62	.21 (.28)	.27	20.86 (3.51)	.96	.24 (.15)	.17	.57 (.74)	.31
Internal	20	.51 (.65)	.44	16.85 (4.97)	.32	.24 (.34)	.40	20.7 (2.9)	.95	.24 (.16)	.24	.80 (.70)	.83

Note. *p* values represent the results of independent samples t-tests conducted to assess differences between each experimental group and the control group.

3.3 Stimuli

During the experimental session participants learned a novel construction in Spanish: direct object pronouns, e.g., *lo* ('him'*)* in *Lo besa María* ('Maria kisses him'). See Table 5 for a presentation of the full paradigm. The Spanish direct object clitic pronoun system encodes syntactic information, such as the theme theta role and accusative case, both of which indicate that the pronoun specifically represents the noun that receives the action of the verb. Additionally, the direct object pronoun encodes other grammatical information, such as: (a) gender information—i.e., masculine, feminine, (b) person information—i.e., first, second, etc., and (c) number information—i.e., singular and plural. However, the current study only presented the third person singular forms—*lo* ('him') and *la* ('her')—as a way of simplifying the presentation of the paradigm, and allowing participants to focus on only one linguistic feature in addition to the syntactic theta role/case information.

Table 5

Paradigm for Spanish Direct Object Pronouns

	Singular		Plural	
Person				
1st	me		nos	
2nd	te		os	
	Masculine	Feminine	Masculine	Feminine
3rd	lo	la	los	las

Note. The 1st and 2nd person pronouns do not encode gender information. The present study will employ only the masculine and feminine 3rd person pronouns.

Direct object pronouns in Spanish have been the object of several previous investigations (DeKeyser & Sokalski, 1996; Morgan-Short & Bowden, 2006; Salaberry, 1997; VanPatten & Cadierno, 1993a; VanPatten & Cadierno, 1993b). These pronouns are often investigated as they prove to be difficult for learners to acquire. This has been posited to be due to the learnability problem this structure poses for L2 learners, as the pronoun appears before the verb and is often the first noun encountered, and therefore may be interpreted as the subject (i.e., the agent) rather than the object (VanPatten & Cadierno, 1993a; VanPatten, 2004). In general, previous research suggests that L2 instruction can bring about linguistic development of the form (Morgan-Short & Bowden, 2006; VanPatten & Cadierno, 1993a; VanPatten & Cadierno, 1993b). Therefore, this linguistic target structure serves as an ideal candidate to test the effects of different instructional interventions. However, no previous investigation has addressed these issues using an online approach such as eye-tracking nor has previous research directly accounted for development of this structure as a function of learner attention, thus motivating the incorporation of this linguistic structure in the present study.

The stimuli consisted of 160 sentences, all of which contained a direct object pronoun, and a series of corresponding images. Each sentence related information about an action that an agent (the subject) performed on a theme (the direct object), where the theme theta role was conveyed by the accusative direct object pronoun. The agent and theme roles expressed in the sentences were always third person singular and animate. Sentences also provided information about the time and place that the action occurred. Stimuli sentences were created using 40 different verbs. To ensure that a lack of familiarity with the verbs did not interfere with comprehension of the sentence verbs were previously

presented to participants in their Spanish class as well as emailed to participants between ten and fourteen days before their participation in the experiment (see § 3.5 for more details on the procedure). Four sentences were constructed around each verb by using the masculine singular direct object pronoun in two sentences and the feminine singular direct object pronoun in two sentences and by varying the time and place information in each sentence. Consider the following four unique examples. The verb *besar* ('to kiss') appears in all of the sentences but the combination of varying agent/theme roles and time/place information creates unique sentences in each example (see Appendix A for a sample of thirty unique stimuli sentences).

(5) *Por la mañana a las ocho,* ***la*** *bes-a en su sala.*
in DET morning at DET eight **PRN-3RD-SG-F** kiss-3RD-SG in DET living room
'At eight in the morning, he kisses **her** in their living room.'

(6) *Por la mañana a las ocho,* ***lo*** *bes-a en el parque.*
in DET morning at DET eight **PRN-3RD-SG-M** kiss-3RD-SG in DET park
'At eight in the morning, she kisses **him** in the park.'

(7) *Por la tarde a las tres,* ***la*** *bes-a en su cocina.*
in DET afternoon at DET three **PRN-3RD-SG-F** kiss-3RD-SG in DET kitchen
'At three in the afternoon, he kisses **her** in their kitchen.'

(8) *Por la noche a las ocho,* ***lo*** *bes-a en su sala.*
in DET evening at DET eight **PRN-3RD-SG-M** kiss-3RD-SG in DET living room
'At eight in the evening, she kisses **him** in their living room.'

These unique sentences were distributed equally between the within-subjects baseline block of trials, the experimental block, and the learning assessment tasks. Each verb appeared no more than once within any particular task. The following target item and sentence characteristics were counterbalanced within each task: (a) masculine and feminine direct object pronouns occurred with equal frequency in each task, (b) the

different time and place information in the sentences occurred with equal frequency in each task. Additionally, the verbs always appeared in the third person singular present tense. It is important to note that the feminine direct object pronoun *la* is homophonous with the feminine determiner in Spanish. Thus, rather than including the determiner *la* 'the' in a position in the sentence downstream from the direct object pronoun, the gender neutral possessive determiner *su* 'his/her' was incorporated, e.g., *en su sala* 'in his/her living room' instead of *en la sala* 'in the living room'.

Additional characteristics of the stimuli are motivated by constraints that are necessary to collect usable eye-tracking data. First, in order to prevent different processing strategies across sentences, the words that appear immediately to the left of the direct object pronoun are matched for frequency and character length and consist of four characters (i.e., *tres* or *ocho*). The character length of the verb that appears immediately to the right of the direct object pronoun is not controlled across sentences, but rather ranges from 3 to 8 characters. In addition, all written stimuli were presented in 18 point Times New Roman font on one line, centered on a computer monitor display screen.

3.4 Experimental Materials

The set of stimuli described in § 3.3 served as the basis for the following language practice materials (in the form of picture-sentence matching activities): (a) two experimental conditions—an external attentional condition and an internal attentional condition, and (b) a control condition. Each of the conditions consisted of two blocks (described in more detail below): (a) a within-subjects baseline block of trials—which all participants completed and (b) an experimental block of trials—involving either an external or an internal manipulation of attention or no manipulation for the control

condition. Additionally, the stimuli described above was used to create a task designed to assess linguistic development (described in more detail in § 3.4.3). In what follows, I will describe the different types of blocks (baseline and experimental) that were designed for each of the three conditions (external, internal and control).

3.4.1 Within-subjects Baseline Block

For each of the conditions (external, internal and control), in order to obtain a baseline measure of the amount of attention that learners allocate to the target form prior to any manipulation of attention, a *within-subjects baseline block* of trials was created and was completed by all participants. The first screen that participants encountered in this block of trials was a screen with instructions that stated a general description of the task followed by directions about which buttons on a six-button game controller participants had to press to advance through the presentation of the items (see Appendix B for the complete instructions for this task). Crucially, participants were not specifically told to focus on or pay attention to any specific aspect of the sentence. Subsequently, this block presented 33 trials, each of which consisted of three slides (see Figure 3). The first three trials were practice trials, presented in English, to familiarize participants with the task. The first slide of each trial presented a stimuli sentence containing a direct object pronoun. The second slide presented two images and specific directions to choose which image best represented the sentence they had read on the previous slide. One of the images presented served as a correct representation of the sentence and one served as an incorrect representation. Incorrect images in the within-subjects baseline trials were representations that differed from the stimuli sentence based on either the time, e.g., *in the morning* instead of *in the afternoon*, the place, e.g., *in the living room* instead of *at the park,*

or the verb, e.g., *to kiss* instead of *to hug*. Importantly, in this within-subjects baseline block, participants were never asked to choose between two pictures that differed based on the agent-theme relationship, as this could have potentially served as a manipulation of learner attention to the pronoun, thus eliminating the within-subjects baseline measure of natural attentional allocation this block of trials was designed to capture. The location of the correct image on the screen—i.e., left side or right side of the screen, was counterbalanced and psuedorandomized across trials so that the correct image did not appear more than three times in a row on one side of the screen.

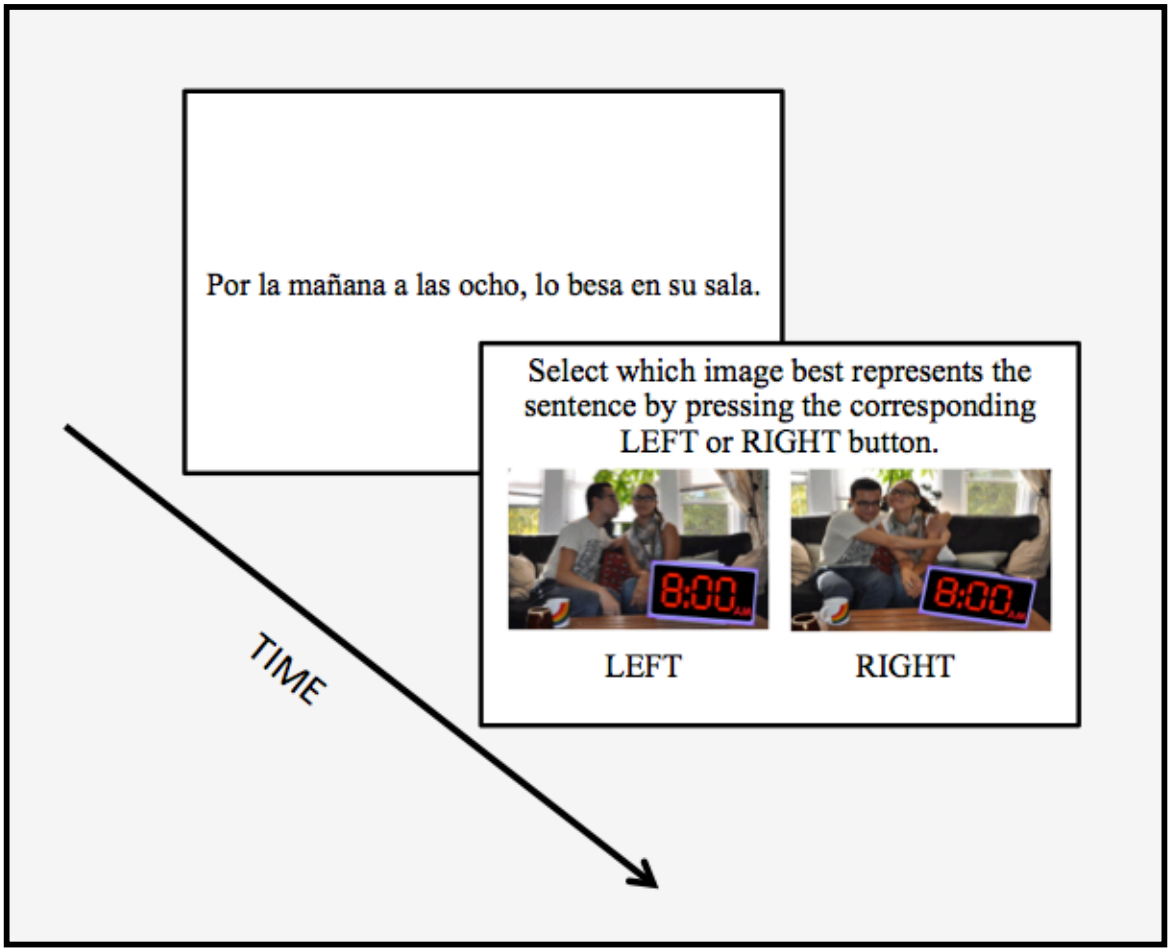

Figure 3. Schematic of a trial from the within-subjects baseline block (administered in all conditions). No manipulation of attention is employed.

3.4.2 Experimental Blocks

For each of the conditions, an *experimental block* of trials was designed in order to examine the effects of external and internal manipulations of attention. The experimental block in each of the conditions consisted of an additional 30 trials that were presented to participants after the within-subjects baseline block. For the control condition, the experimental block was identical to the within-subjects baseline block with regard to instructions, and the task completed (i.e., there was no manipulation of attention employed) with the exception of the provision of written feedback (i.e., *Correct!* or *Incorrect!*). See Figure 4 for a schematic of a trial in the experimental block in the control condition. Conversely, for the two experimental conditions (external and internal), important modifications were made to the stimuli sentences and the number of times the images were displayed (see immediately below for details). These modifications depended on whether an external or internal manipulation of attention was employed.

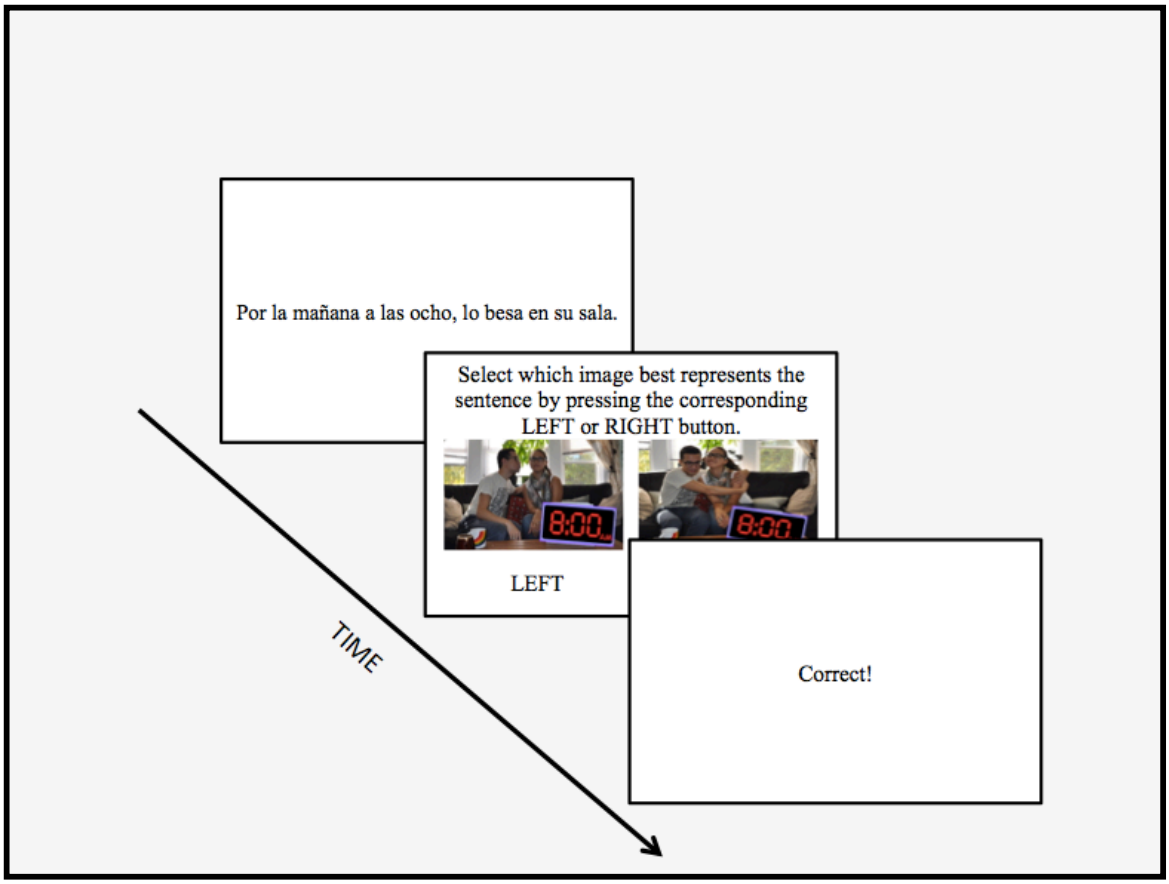

Figure 4. Schematic of a trial from the experimental block in the control condition. No manipulation of attention is employed.

There were some similarities across conditions on the experimental blocks, these will be described first for ease of comparison. First, in each of the conditions, the experimental blocks contained instructions that provided a general description of the task to be completed, as well as a description of how to advance through the trials (see Appendix C for instructions for the external condition, Appendix D for instructions for the internal condition and Appendix E for instructions for the control condition). Again, these instructions did not direct participants to focus on or pay attention to the direct object

pronouns in any way. Next, all experimental blocks regardless of condition, presented participants with three practice trials in English to familiarize them with the task. Lastly, feedback about the correctness of the participant's response (i.e., *Correct!* or *Incorrect!)* was provided in the experimental blocks in all three conditions to reinforce participants' correct responses and foster learning.

3.4.2.1 Experimental Block: External Attentional Condition

For the external attentional condition the experimental block of trials consisted of a picture-sentence matching activity (as described above) where IE in the form of textual enhancement of the direct-object pronoun was implemented when the stimuli sentence was displayed. This served as an external manipulation of attention (see Figure 5 for a schematic of a trial in this block). As a reminder, external attentional manipulations in cognitive psychology involve augmenting the saliency of the stimuli as a way of manipulating external cues. For the purposes of the current study, this manipulation consisted of a font change for the linguistic target form embedded in the stimuli sentence. More specifically, following Winke (2013), the direct object pronoun presented in the stimuli sentence on the first slide of each trial was displayed in red while the rest of the sentence was displayed in black. Thus the target form was enhanced, following previous research on IE, and is expected to bring external attention to the target form. With the exception of the IE modification and an added third slide that provides feedback about the participant's response all other aspects of this block within the external attentional condition are identical to the control block of trials and the within-subjects baseline block of trials.

Note that the two images presented never contrasted with regard to the target form (i.e., which actor was performing the action and which was receiving the action). This decision was carried out so that the manipulation employed was purely an external manipulation of attention. That is, if the two images had differed based on the direct-object pronoun, this manipulation of the demands of the task would have served as an internal manipulation of attention. Thus, any results obtained for this condition would not have been able to directly speak to the affects of external manipulations of attention on attentional allocation and linguistic development. Given this, we opted to avoid this confound by making the two images differ based on other information in the sentence (i.e., the time information, the place information or the action that was depicted), as was done in the control condition.

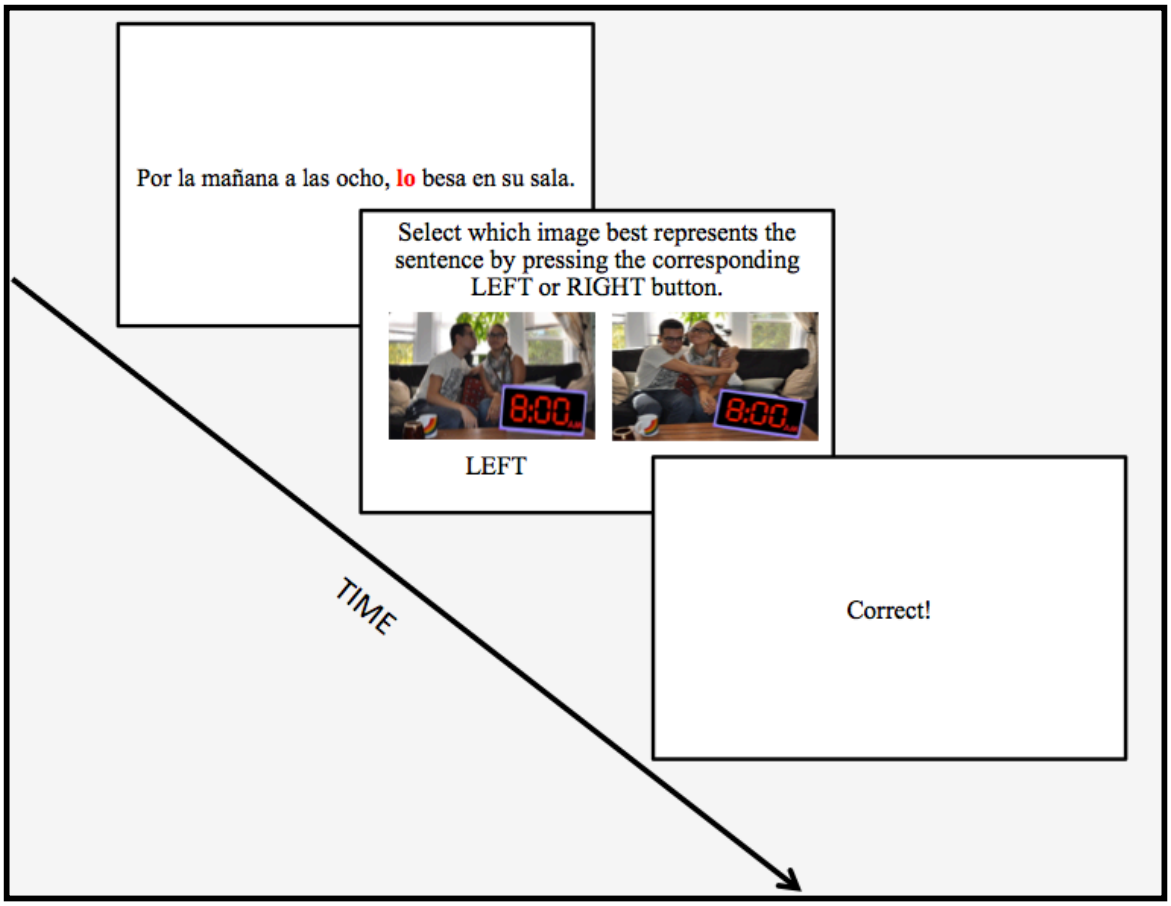

Figure 5. Schematic of a trial from the experimental block in the external attentional condition. The direct object pronoun 'lo' ('him') is red the first slide in order to manipulate external attention.

3.4.2.2 Experimental Block: Internal Attentional Condition

The experimental block in the internal attentional condition consisted of SI practice, which has previously been shown to have positive effects on development in the absence of explicit information (e.g., Fernandez, 2008; see Figure 6 for a schematic of a trial in this block). As a reminder, internal attentional manipulations in cognitive psychology involve the manipulation of internally generated information via task demands and response

selection to stimuli items. In this experimental block of trials in the internal attentional condition, as in the external attentional condition, and control condition participants completed a picture-sentence matching task. However, in this condition and specifically on the experimental block of trials, the task demands were manipulated using SI practice, which presented a pair of contrasting images both before and after the sentence was displayed and consequently aimed to manipulate internal attention. Additionally, response selection in this condition was dependent on correctly interpreting the direct object pronoun. Crucially, all image pairs presented in this condition differed based only on which actor realized the theme theta role of the verb, e.g., *him* instead of *her*.

On any given trial in this block, on the first slide, participants saw two images: for example, an image that depicted *a boy kissing a girl* and an image that depicted *a girl kissing a boy*. On the next slide, they read the stimuli sentence containing the masculine direct-object pronoun, *lo* 'him'. Next, on the third slide, they saw the same two images that had been displayed on the first slide and were asked to decide which image best represented the sentence they had read on the previous slide. Lastly, on the fourth slide, participants received feedback about their decision, which should have influenced their response selection on subsequent trials. In order to correctly choose the image that depicts *a girl kissing a boy*, participants should have focused on the linguistic information that conveyed which person received the action in the sentence (i.e., the direct object pronoun). Thus, by employing a standard SI practice design, the demands of the task, i.e., the presentation of the two images prior to reading the stimuli sentence, and the selection of which image best represents the sentence should have manipulated internal attention and consequently

direct it to the distinguishing linguistic information, which is uniquely conveyed by the direct object pronouns in the stimuli sentences.

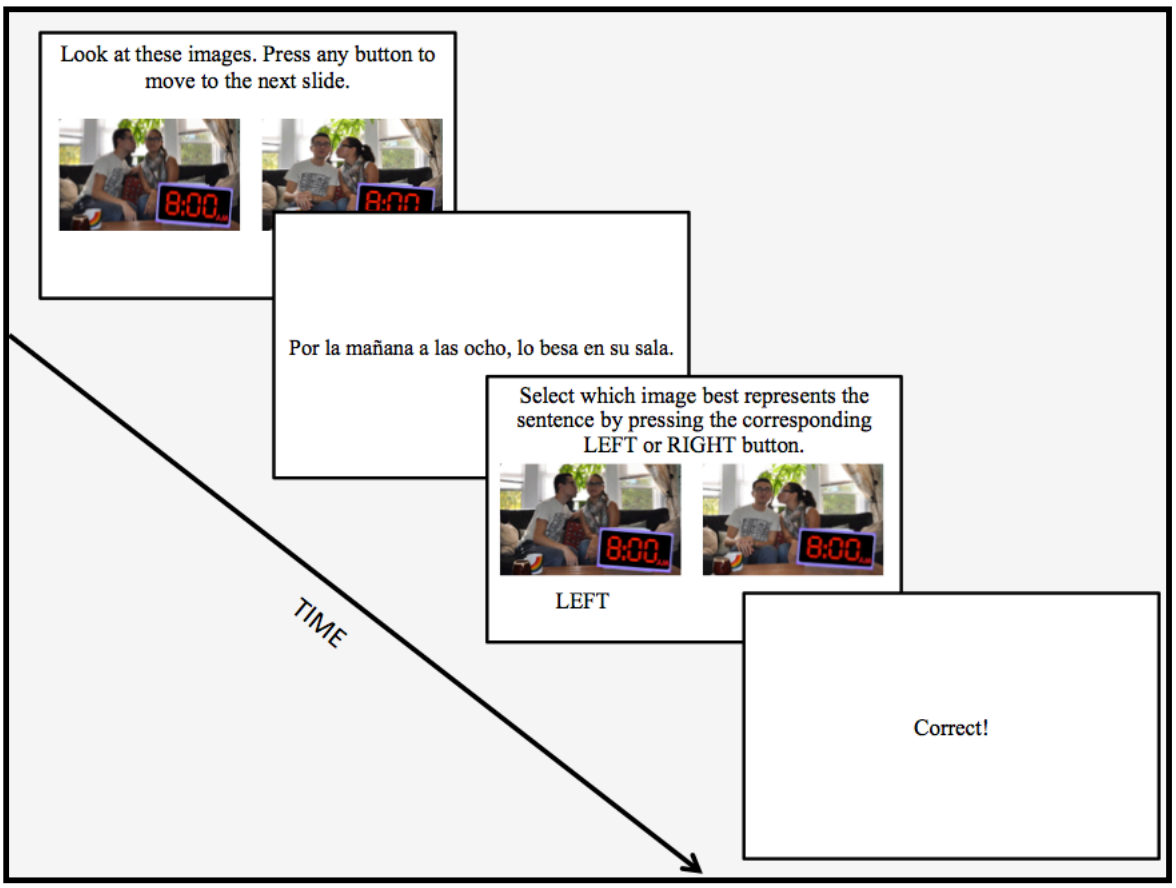

Figure 6. Schematic of a trial from the experimental block in the internal attentional condition. Two contrasting images are presented before participants read the sentence to push participants to process the pronoun 'lo' ('him') in order

3.4.3 Linguistic Development Assessment

Finally, in order to assess L2 linguistic development related to the target item, one *learning assessment task*, which was adapted from previous PI research (Morgan-Short & Bowden, 2006; Sanz & Morgan-Short, 2004; VanPatten & Cadierno, 1993b), was employed.

This task was designed to measure participants' interpretation and comprehension direct objects pronouns in Spanish at a sentence level. Crucially, the inclusion of this type of task also allows the results of the present study to be interpretable in relation to previous research. In order to prevent task effects such as raising metalinguistic sensitivity, the assessment measures will not be specifically labeled as such, but rather labeled as *Task 1*, *Task 4*, etc. and will appear to participants as just another task in the experiment. Before completion of the interpretation assessment task, participants read a screen that provided instructions that gave a general description of the task and directions related to what buttons to press on the six-button game controller in order to advance through the task (see Appendix E for interpretation assessment instructions). As with the instructions in the other tasks in the experimental session, these instructions did not specifically direct participants to focus on or pay attention to the direct object pronouns, thus avoiding any bias in performance due to instructions. Before completion of each assessment task, participants were presented with three practice items in English, in order to familiarize them with the task procedure.

The interpretation test gauged how well participants were able to comprehend the theme theta role expressed by direct object pronouns. This assessment consisted of a picture-sentence matching task with 10 critical items where participants read a novel stimuli sentence, saw two images, which differed only in regard to the direct object, and decided which image best represented the sentence (see Figure 7). Thus in order to respond correctly, participants must have interpreted the theme theta role expressed by the direct object pronoun. Twenty additional distractor items, which had the same format as the critical items, were also presented. However, for these distractor items, the

difference between the two images was not related to the theme theta role (i.e., the actor that receives that action of the verb) but rather depicted differences in information related to the time, the action itself or the place where the action occurs. Three versions of the assessment were created and administered as the pre, post and delayed assessments and the distractor and critical items were counterbalanced across versions. The pre and post-assessments were administered via a Latin square design so that each participant was exposed to all versions of each assessment only once.

Figure 7. Schematic of learning assessment. A Sample critical item from the interpretation test (left): The only difference between the images is who is performing and who is receiving the action. Sample distractor item from the interpretation test (right): The difference between the images is related to the time when the action takes place (i.e., 8:00 A.M. or 8:00 P.M).

3.4.4 Non-experimental Tasks

3.4.4.1 Language Background Questionnaire

As mentioned above, as part of the pre-screening process participants completed a language background questionnaire over the phone with the researcher or a trained research assistant. This questionnaire is one commonly used in the Cognition of Second Language Acquisition Laboratory at UIC and elicited: (a) general demographic information (such as, age, race/ethnicity, gender, educational background of the participant and their parents) and (b) information about participants' language background (i.e., how many languages they know, when and where they learned them), as well as information about their weekly use of Spanish outside of the classroom (see Appendix G for the full questionnaire).

3.4.4.2 Vocabulary Test

Before completing the pre-test learning assessment participants completed a vocabulary test. This multiple-choice test consisted of 40 items that presented the infinitive form of the verbs (e.g., *besar*, 'to kiss') that were used in the stimuli sentences and three possible English translations, which were also presented in the infinitive form (e.g., 'to kiss', see Appendix H for sample items from the vocabulary test). This vocabulary test was administered to assess participants' knowledge of the meaning of the verbs in order to control for vocabulary knowledge as a potential item level effect.

3.4.4.3 Debriefing Interview

Upon completion of the experimental materials, on the last day of the experiment, participants answered a series of debriefing questions through a short oral interview with the researcher or a trained research assistant. The purpose of this interview was to assess

whether participants were aware of what was being specifically tested in the experiment, and to ensure that they had no prior knowledge of the direct object pronoun. Additionally, the questions asked if participants had specifically studied the direct object pronouns in the two weeks between the first session and second session in order to ensure no participants received additional instruction (besides the experimental treatment) on the direct object pronouns before completing the delayed assessment (see Appendix I for the full set of questions asked in the debriefing interview).

3.5 Procedure

Participants were recruited from first-semester, introductory Spanish courses at UIC during the following semesters: Spring 2014, Summer 2014, Fall 2014 and Spring 2015 and pre-screened over the phone by completing the language background questionnaire described above. The recruitment and pre-screening took place approximately 3 weeks before the experimental sessions began (i.e., the 11th week of the semester). Only those participants who met the language requirements (i.e., studied Spanish or another Romance language for less than one year, were not Spanish-English bilinguals) were scheduled to participate. As participants were scheduled, they were provided with a vocabulary study sheet via email that contained the list of 40 verbs used in the experimental stimuli, a set of accompanying photos depicting the verbs, and the English translations. Although the majority of these verbs had been previously presented in their class, participants were asked to review the meaning of the verbs before participating in the study. Participants were randomly assigned to either the external attentional condition, the internal attentional condition or the control condition.

Data collection took place over the course of two sessions for each participant. The procedure for the first session, which took about an hour to complete, was as follows: Participants first provided informed consent, and completed the multiple-choice vocabulary test. Next, participants completed the self-paced computer-based tasks in the following order: (1) learning assessment task—pre-test; (2) within-subjects baseline block—measure of learners' natural attentional allocation; (3) the experimental block—external manipulation, internal manipulation or no manipulation of attention; (4) learning assessment task—immediate post-test. Participant eye-movements were recorded while seated approximately 80 cm in front of a computer monitor as they completed the *within-subjects baseline block* and the *experimental block* with an Eye-Link II (SR-Research) head-mounted eye-tracker with a monocular sampling rate of 500 Hz, tracking the right eye. While eye-movements were tracked participants were required to rest their chin in a desk-mounted chin rest to minimize head movement and any resultant tracking loss. Before completing the within-subjects baseline block, the eye-tracker was calibrated following a 9-point calibration. During the within-subjects baseline block and the experimental block, before each sentence was displayed, a drift correct dot appeared approximately half an inch to the left of where the sentence would appear on the following screen. This allowed for greater tracking accuracy while participants read the stimuli sentences by preventing gaze drift. Participants responded to the task using a 6 button game controller. At the end of the first session, participants were scheduled for a follow-up learning assessment session between 12 and 14 days later (on average participants completed the second session 13.5 days after the first).

The procedure for the second session, which took about 30 minutes to complete, was as follows: Participants provided informed consent, completed the delayed learning assessment (as described above) and completed the debriefing interview (as described above). Lastly, participants were compensated approximately $52.00 for their participation.

3.6 Scoring and Analysis

The two attentional manipulations employed here and their implementation through instructional interventions are inherently different and thus quantitative comparisons between the two attentional manipulations with regard to how attention is manipulated and whether they lead to learning in differential ways are not particularly fruitful. Indeed, the analysis conducted here reflects this way of thinking in that there are no direct quantitative comparisons between the external attentional condition and the internal attentional condition.

In what follows, before describing the specific statistical tests employed, I will lay out the crucial comparisons that will provide insight into whether attentional allocation was affected and whether L2 development took place under each of the experimental conditions. Note that henceforth, I will refer to the participants who completed the external attentional condition as the *external group*, the participants who completed the internal attentional condition will be referred to as the *internal group* and the participants who completed the control condition, will be referred to as the *control group*.

With regard to attentional allocation, I compared the amount of attention allocated to the pronoun on the within-subjects baseline block (indexed by the eye-tracking measures described immediately below) to those same measures from the experimental

block *within* each group (external, internal and control). Furthermore, in order to ensure that the any effects of attentional allocation were not just due to exposure to the target form, measures of attention obtained from each of the experimental groups (external and internal) were compared to those obtained by the control group.

A similar approach was utilized to examine whether L2 development took place under the two attentional conditions. That is, within-subjects comparisons were made by comparing the pre-test to immediate post-test and pre-test to delayed post-test *within* each group and between-subjects comparisons were made by comparing each experimental group to the control group (external versus control; internal versus control). In the following sections, I describe the measures used to index attention and learning and the statistical tests conducted to answer the research questions laid out in § 2.9.1 above (which are repeated here for ease of presentation).

3.6.1 Eye-tracking Data

The eye-tracking device used in the present study provides a wealth of data about participants' eye-movements. We will be primarily concerned with fixations (i.e., brief pauses in eye-movements where participants' gaze is held on particular areas of interest of the stimuli sentences) on the target form as an index of overt attention. All fixations that were less than 50ms or greater than 1000ms were excluded from the data set as it is thought that participants are not able to extract useful information from text during a fixation less than 50ms in duration (Inhoff & Radach, 1998). Additionally, fixations longer than 1000ms are thought to reflect distraction or fatigue (Keating, 2013). These cutoffs resulted in an exclusion of 1.8% of the data recorded during the within-subjects baseline

block across all participants and 1.6% of data for recorded during the experimental blocks across all participants. Based on previous research we will examine four eye-tracking measures in order to obtain a holistic picture of participants' eye-movement record (Rayner, 1998; 2009). The following eye-tracking measures were averaged across trials and considered for analysis: (a) gaze duration—i.e., the total duration of all fixations on the direct-object pronoun until the participant exits the word to the right or to the left, (b) total time—i.e., the total duration of all fixations on the direct-object pronoun, including any fixations that were a result of participant eye-movements regressing back to the pronoun after having exited the region, (c) first-pass skipping rate—i.e., the percentage of trials where direct object is skipped over on the participants' first pass in reading from left to right, (d) overall skipping rate—i.e., percentage of trials where the participant skipped over the direct object pronoun entirely. The examination of gaze duration and total time are motivated by previous L2 research that has examined attention and L2 development with eye-tracking (Godfroid et al., 2013; Godfroid et al., 2010; Godfroid & Schmidtke, 2013; Godfroid & Uggen, 2013, Winke, 2013), thus for these measures, if the attentional manipulations employed affect attentional allocation, we would expect to see fixations on the pronoun with increased durations. On the other hand, the examination of skipping rate (both first-pass and overall skipping rate) is motivated by previous research that has found that shorter words are skipped over more often (Brysbaert, Drieghe, & Vitu, 2005; Rayner, 1998). Thus, considering that the Spanish direct-object pronouns investigated in the present study consist of two characters, the likelihood of participants skipping over them when their attention is not directed towards them is high, resulting in high skipping rates.

Thus, if the attentional manipulations employed affect attentional allocation, we would expect a decrease in skipping rates.

These measures can be grouped along two dimensions: (a) whether they measure duration (gaze duration and total time) or quantity of fixations (first-pass skipping rate and overall skipping rate) and (b) whether they are thought to reflect early, more automatic cognitive processes such as sensory processing or motor control (gaze duration, first-pass skipping rate) or later, more controlled cognitive processes such as semantic integration, ambiguity resolution (total time and overall skipping rate).

The following statistical tests were conducted on each eye-tracking measure in order to answer **RQ1A**: *Do instructional interventions that involve an* ***external manipulation of*** *attention lead learners to allocate overt* ***attention*** *to a novel linguistic target form?* and **RQ2A**: *Do instructional interventions that involve an* ***internal*** *manipulation of attention lead learners to allocate overt* ***attention*** *to a novel linguistic target form?*

For each experimental group and the control group, the eye-tracking measures described above were submitted to separate 2 x 2 repeated-measures ANOVAs with Block (within-subjects baseline, experimental) as a within-subjects factor and Group (external *or* internal, control) as the between-subjects factor. These ANOVAs allowed us to compare the eye-tracking measures obtained within each group on the within-subjects baseline trails to those obtained when the attentional manipulation was employed on the experimental block. Additionally, the inclusion of the control group as a between-subjects factor allowed us to assess whether the experimental groups performed differently than the control group, which was only exposed to the target form through practice but with no manipulation of attention. Note that the same control group is compared to each of the

experimental groups. Follow-up repeated measures ANOVAs were conducted within each group (external or internal, control) when a significant main effect or interaction was evidenced to assess which group was driving the effects.

3.6.2 Linguistic Development Assessment Task

Responses on the interpretation task items were scored as either correct or incorrect. Participants received one point for correct answers and a score of zero points for incorrect answers. These scores were automatically generated by Experiment Builder. Immediate learning gain scores were calculated by subtracting accuracy on the pre-test from the accuracy scores obtained on the immediate post-test. Similarly, delayed learning gain scores were calculated by subtracting average accuracy scores on the pre-test from average accuracy scores on the delayed post-test.

In order to answer **RQ1B:** *Do instructional interventions that involve an **external** manipulation of attention bring about **learning** of a novel linguistic target form?* and **RQ2B:** *Do instructional interventions that involve an **internal** manipulation of attention bring about **learning** of a novel linguistic target form?* Scores from the interpretation tests for each experimental group were submitted to separate 3 x 2 repeated-measures ANOVAs with Time (pre-test, immediate, delayed) as a within-subjects factor and Group (external *or* internal, control) as a between-subjects factor. These ANOVAs allowed us to compare accuracy on the pre-test to the immediate and delayed post-tests, as well as compare the accuracy on the immediate post-test to the delayed post-test to assess durability of learning effects. Additionally, the inclusion of the control group as a between-subjects factor allowed us to assess whether the experimental groups performed differently than the control group on any of the interpretation tests. Again, note, that each experimental

group is compared to the same control group. Follow-up Bonferroni-corrected pair-wise comparisons were conducted to explore any main effects and interactions that were evident.

Lastly, in order to answer **RQ1C:** *Does overt **attention** directed to a novel linguistic target form by an **external** manipulation of attention account for **learning** of that form?* and **RQ2C:** *Does overt **attention** directed to a novel linguistic target form by an **internal** manipulation of attention account for **learning** of that form?*

Scores from the learning assessment tasks (measures of learning) and each of the eye-tracking measures (indices of overt attention) for each group were submitted to simple linear regression analyses. The gain scores on the learning assessment tasks served as the predicted variable and the eye-tracking measures that evidenced a significant change served as the predictor variables in each of the regression models.

4. RESULTS

4.1 Introduction

This dissertation was designed to examine how external and internal manipulations of attention bring about L2 development of a novel morphosyntactic target form—Spanish direct-object pronouns. In the following sections, I will report the results of the statistical tests utilized (as explained in more detail above in Chapter 3, § 3.5) to answer the research questions presented in Chapter 2 (§ 2.10). As a reminder to the reader, there are two key types of comparisons to be made with regard to attentional allocation and learning: within-subjects comparisons and between-subjects comparisons. For the within-subjects comparisons, attentional allocation to the pronoun during the within-subjects baseline block will be compared to attentional allocation to the pronoun on the experimental block for each group (external, internal, control). Regarding linguistic development, within-subjects comparisons will be made by comparing the pre-test to the delayed post-tests within each group. For the between-subjects comparisons, each of the experimental groups (external and internal) will be compared to the same control group.

Results from the ANOVAs conducted to assess whether these changes were statistically significant will be reported along with the effect size measure of η^2 which indicates the amount of variance explained by the change from baseline to experimental block in the eye-tracking measures examined here or the change from pre-test to post-tests for the linguistic development data. Thus, we can better understand the practical significance of the effect by interpreting this value relative to the following conventions for L2 research where 0.06 is a small effect, 0.16 is a medium effect and 0.36 is a large effect (Plonsky & Oswald, 2014). For comparisons from pre-test to post-tests for the linguistic

development data, I will follow Plonsky and Oswald's conventions for interpreting Cohen's *d* for within-subjects experimental designs in L2 research and interpret 0.60 as a small effect, 1.00 as a medium effect and 1.4 as a large effect. For comparisons between groups (external vs. control or internal vs. control) I will follow Plonsky and Oswald's conventions for between-subjects designs and interpret 0.40 as a small effect, 0.70 as a medium effect and 1.00 as a large effect.

The sections in this chapter are organized as follows: § 4.2 describes results from the vocabulary test administered before the experimental session to ensure that participants had a working knowledge of the L2 vocabulary needed to successfully complete the experimental tasks. Next, in § 4.3, I focus on the external group, where I report the results regarding: (a) effects on attentional allocation (§ 4.3.1), (b) effects of L2 linguistic development (§. 4.3.2) and (c) the results from the linear regression analysis conducted to assess whether attentional allocation under the external condition can account for any L2 linguistic development (§ 4.3.3). Similarly, in § 4.4, I focus on the internal group and report the results regarding: (a) effects of the internal attentional condition on attentional allocation (§ 4.4.1), (b) effects of L2 linguistic development (§ 4.4.2) and (c) the results from the linear regression analysis conducted to assess whether attentional allocation can account for L2 linguistic development under the internal attentional condition (§ 4.4.3).

4.2 Vocabulary Test

Results from the vocabulary test revealed that all participants had knowledge of the vocabulary before participating in the experiment (overall accuracy: $M = 0.89$, $SD = 0.11$) at above chance levels as indicated by a one-sample *t*-test ($t(54) = 38.548$, $p < 0.001$). No item

was responded to with less than 70% accuracy. Lastly, there were no significant differences between the control group (M = 0.87, SD = 0.10) and either of the experimental groups (external: M = 0.86, SD = 0.13; internal: M = 0.93, SD = 0.08) with regard to accuracy on the vocabulary test (external vs. control: $t(33) = 0.270$; $p = 0.789$; internal vs. control: $t(32) = 1.910$; $p = 0.065$). These results suggest that any differences between the experimental groups and the control group are not due to superior knowledge of the vocabulary items used in the stimuli but are more likely to be due to the experimental manipulations.

4.3 External Attentional Condition

4.3.1 Attentional Allocation

The external group and control group means for the eye-tracking measures used to assess attention allocated to the direct object pronoun are displayed in Table 6. These measures are displayed for the within-subjects baseline block (i.e., where there was no manipulation of attention) as well as for the experimental block where IE was employed (i.e., where the pronoun was displayed in red). For the external group, the following descriptive patterns were apparent in the data relative to the within-subjects baseline block: (a) average gaze duration did not change, (b) average total time on the pronoun increased, (c) average first-pass skipping rate decreased, and (d) overall skipping rate decreased.

Table 6

Descriptive Results from Eye-tracking Measures for the External Attentional Condition

Group	*N*	Gaze Duration (ms)		Total Duration (ms)		First-pass Skipping Rate (%)		Overall Skipping Rate (%)	
		M (SD)		*M (SD)*		*M (SD)*		*M (SD)*	
		Baseline Block	Experimental Block	Baseline Block	Experimental Block	Baseline Block	Experimental Block	Baseline Block	Experimental Block
External	21	250 (76)	248 (74)	387 (152)	486 (249)	82.86 (10.56)	55.23 (18.74)	42.86 (24.11)	19.36 (12.45)
Control	14	276 (87)	254 (69)	358 (158)	333 (153)	73.57 (22.78)	76.90 (18.74)	43.33 (23.17)	47.34 (18.77)

Note. ms = milliseconds.

The duration-based measures of gaze duration and total time were examined with separate 2 x 2 repeated-measures ANOVAs. For gaze duration, the ANOVA revealed no main effects (Block: $F(1,32) = 0.565$, $p = 0.458$, $\eta^2 = 0.017$; Group: $F(1,32) = 0.512$, $p = 0.48$, $\eta^2 = .016$) or interactions (Block x Group: $F(1,32) = 0.399$, $p = 0.532$, $\eta^2 = 0.012$)—See Figure 8. Similarly, the ANOVA for total time yielded no main effects (Block: $F(1,33) = 0.976$, $p = 0.330$, $\eta^2 = .029$; Group: $F(1,33) = 2.942$, $p = 0.096$, $\eta^2 = 0.082$), or interactions (Block x Group: $F(1,33) = 2.709$, $p = 0.109$, $\eta^2 = 0.076$)—see Figure 9. Thus no change in duration-based measures of attentional allocation was evidenced for the external group.

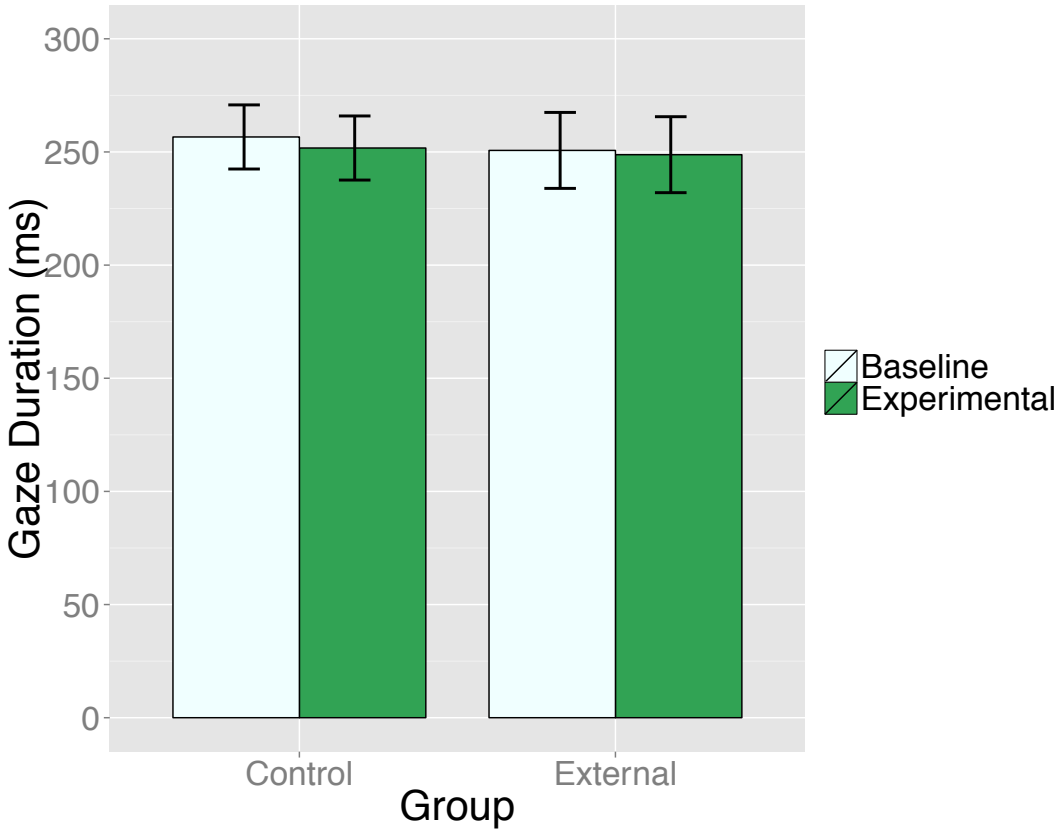

Figure 8. Gaze duration in milliseconds on the direct-object pronoun. Grouped bars represent data from separate groups (control and external). The lighter shaded bar represents data from the within-subjects baseline block and the darker shaded bar represents data from the experimental block. Error bars

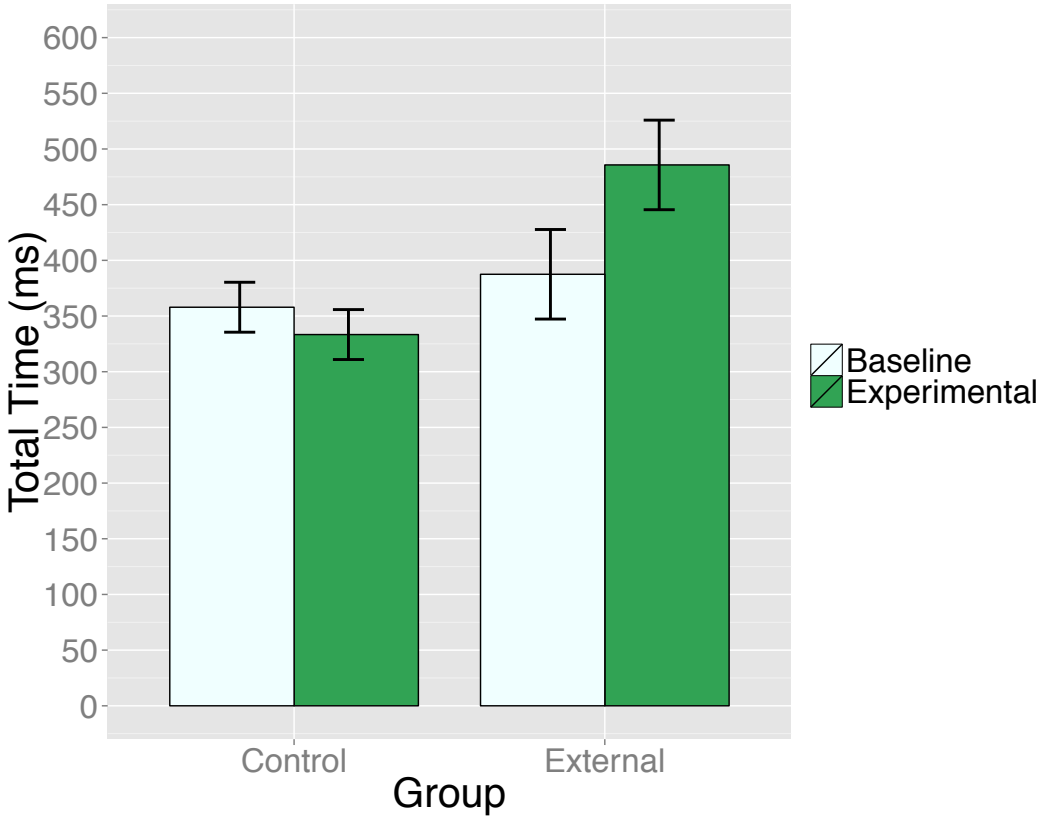

Figure 9. Total time in milliseconds on the direct-object pronoun. Grouped bars represent data from separate groups (control and external). The lighter shaded bar represents data from the within-subjects baseline block and the darker shaded bar represents data from the experimental block. Error bars

A different pattern of results, however, was evidenced for the quantity-based measures of first-pass skipping rate and overall skipping rate, which were also examined with separate 2 x 2 repeated-measures ANOVAs. Results from the ANOVA conducted on first-pass skipping rate yielded a significant main effect for Block ($F(1,33) = 13.325$, $p = 0.001$, $\eta^2 = 0.288$) and a significant interaction between Block and Group ($F(1,33) = 21.644$, $p < 0.001$, $\eta^2 = 0.396$), but no significant effect of Group ($F(1,33) = 1.425$, $p = 0.241$, $\eta^2 = 0.041$). Follow-up repeated-measures ANOVAs within each group (external and control)

confirmed that the first-pass skipping rate significantly decreased on the experimental block relative to the within-subjects baseline block for the external group ($F(1,20) = 49.862$, $p < 0.001$, $\eta^2 = 0.714$) but not for the control group ($F(1,13) = 0.346$, $p = 0.566$, $\eta^2 = 0.026$)—see Figure 10. Similarly, results from the 2 x 2 repeated-measures ANOVA conducted on overall skipping rate yielded significant main effects for Block ($F(1,33) = 8.116$, $p = 0.008$, $\eta^2 = 0.197$) and Group ($F(1,33) = 4.687$, $p = 0.038$, $\eta^2 = 0.124$) and a significant interaction between Block and Group ($F(1,33) = 14.979$, $p < 0.001$, $\eta^2 = 0.312$). Follow up repeated-measures ANOVAs within each group (external and control) confirmed that the overall skipping rate significantly decreased on the experimental block relative to the within-subjects baseline block for the external group ($F(1,20) = 27.487$, $p < 0.001$, $\eta^2 = 0.579$) but not for the control group ($F(1,13) = 0.453$, $p = 0.513$, $\eta^2 = 0.034$). See Figure 11 for a graphic representation of both groups' overall skipping rate on the within-subjects baseline and experimental blocks. Thus, attentional allocation appears to be affected by the external manipulation (i.e., when the pronoun is turned red), at least with regard to how often the direct-object pronoun is fixated.

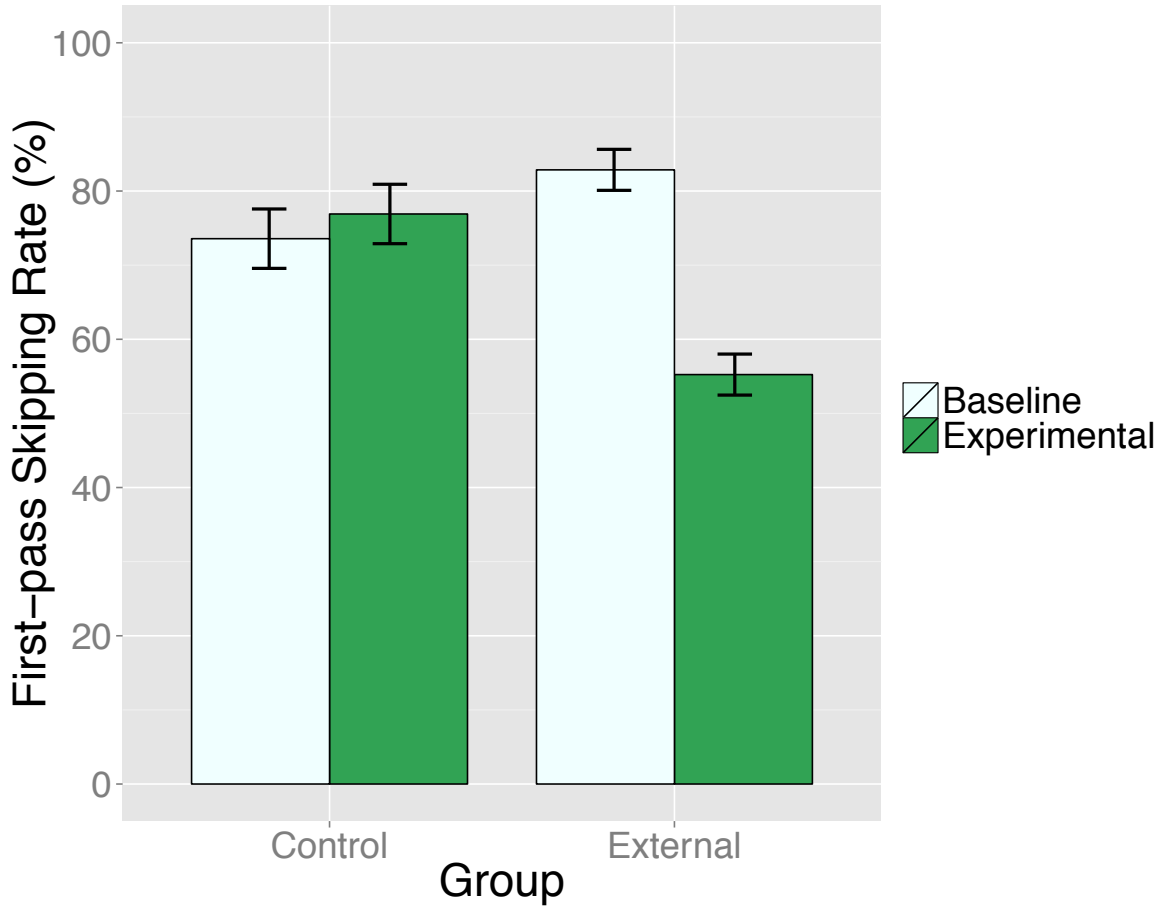

Figure 10. First-pass skipping rate of the direct-object pronoun. Grouped bars represent data from separate groups (control and external). The lighter shaded bar represents data from the within-subjects baseline block and the darker shaded bar

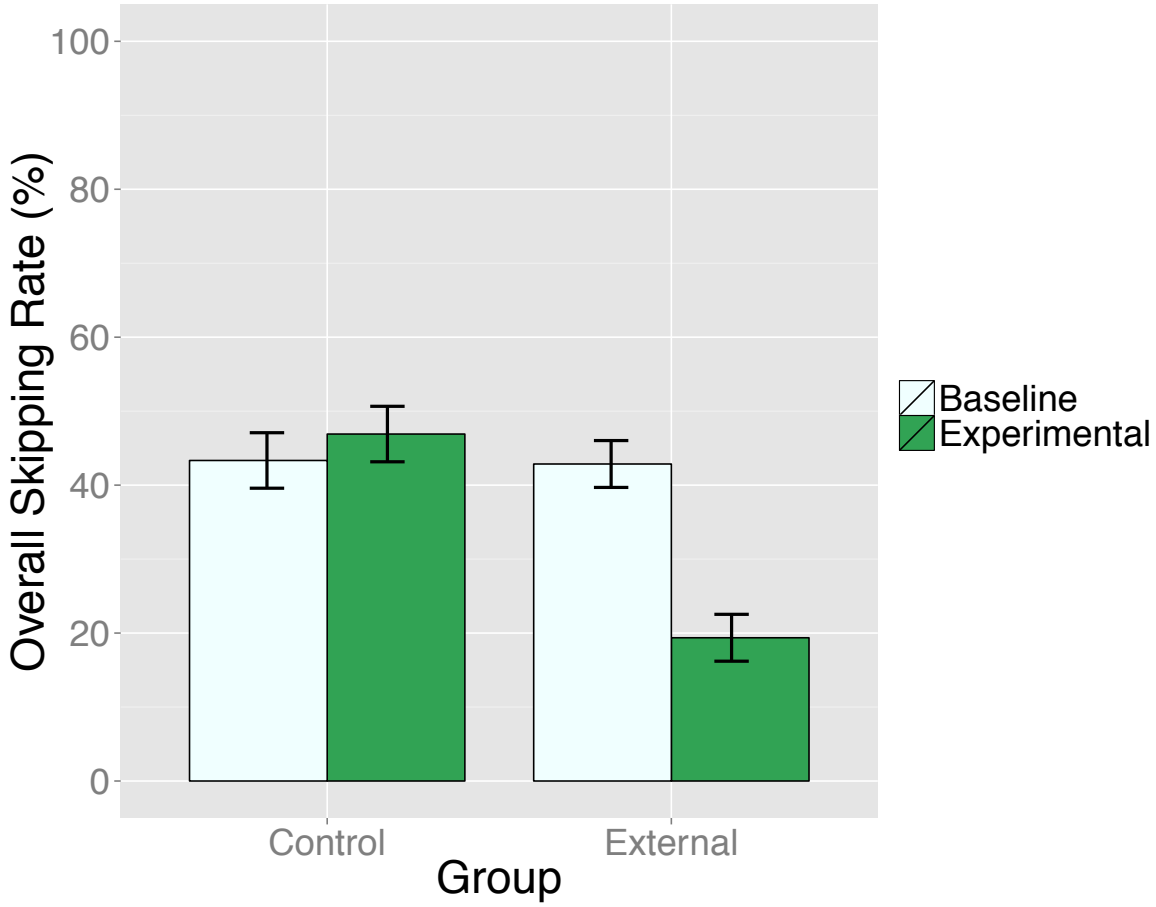

Figure 11. Overall skipping rate of the direct-object pronoun. Grouped bars represent data from separate groups (control and external). The lighter shaded bar represents data from the within-subjects baseline block and the darker shaded bar

4.3.2 Linguistic Development

Group means for the external manipulation and control groups on the pre-test, immediate and delayed post-tests used to assess L2 linguistic development of the target form are displayed in Table 7. Descriptively, we observed that accuracy increased from pre-test to immediate post-test and increased again from immediate to delayed post-test for the external group and to a lesser degree for the control group. Greenhouse-Geisser

corrected results from the 3 x 2 repeated measures ANOVA that assessed development revealed a main effect for Time ($F(2,66) = 18.975$, $p < 0.001$, $\eta^2 = 0.365$) but did not yield a significant Time by Group interaction ($F(2,66) = 1.909$, $p = 0.167$, $\eta^2 = 0.055$), nor a significant main effect of Group ($F(1,33) = 0.153$, $p = 0.698$, $\eta^2 = 0.005$). In order to confirm the learning effect existed in each group, separate follow-up ANOVAs were conducted within each group. A main effect of Time was evidenced in the external group ($F(2,40) = 19.391$, $p < 0.001$, $\eta^2 = 0.492$). Follow-up Bonferroni-corrected pairwise comparisons among each time point revealed significant gains from pre-test to immediate post-test ($p = 0.003$, $d = 0.92$) and pre-test to delayed post-test ($p < 0.001$, $d = 1.35$). Interestingly, although, a main effect was also found for the control group ($F(2,26) = 4.117$, $p = 0.044$, $\eta^2 = 0.241$), pairwise comparisons did not show significant gains from pre-test to immediate post-test ($p = 0.199$, $d = 0.54$) or from pre-test to delayed ($p = 0.112$, $d = 0.65$). These results indicate that developmental gains have taken place for the external group but not for the control group (see Figure 12).

Table 7

Accuracy on Learning Assessment Measure for External Attentional Condition

Group	*N*	Pre	Immediate	Delayed
		M (*SD*)	*M* (*SD*)	*M* (*SD*)
External	21	.24 (.15)	.52 (.35)	.62 (.29)
Control	14	.31 (.16)	.48 (.28)	.50 (.28)

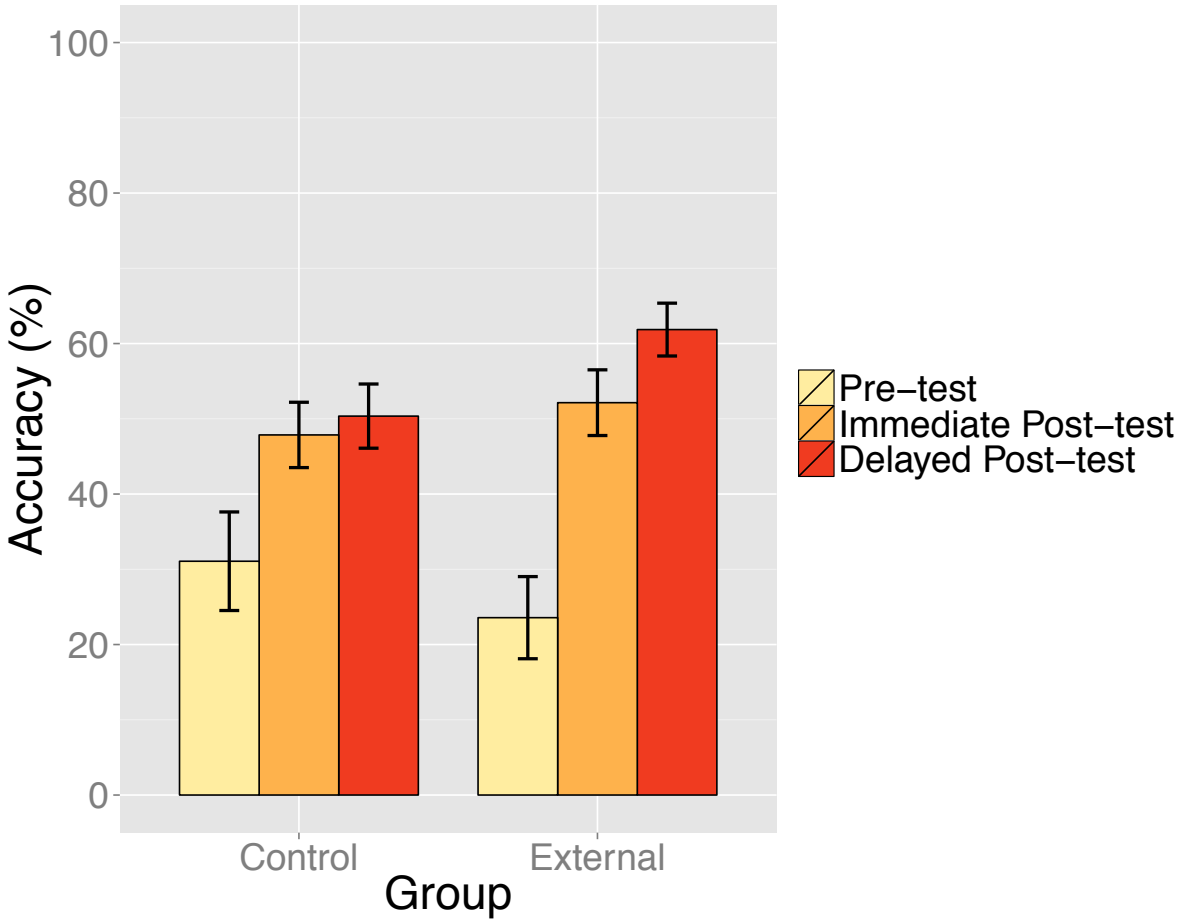

Figure 12. Accuracy on the learning assessment. Grouped bars represent data from separate groups (control and external) at pre-test, immediate post-test and delayed post-test ordered as such from left to right. Error bars represent within-subjects

However, note, that the scores for the external group are relatively low (out of a maximum score of 100% for perfect accuracy: immediate post-test: $M = 0.52$, delayed post-test: $M = 0.62$). Thus, in order to assess whether the level of accuracy obtained at the immediate post-test and delayed post-tests for the external group were significantly different than chance, post-hoc one-sample *t*-tests were conducted (with the test-value set to 0.5) and revealed that the score obtained at the immediate post-test was *not* significantly

different than chance-level ($t(20) = 0.282$, $p = 0.781$), while the score at the delayed post-test yielded a trend to a significant difference from chance-level ($t(20) = 1.896$, $p = 0.073$). Similar results were obtained for the control group, which also evidenced relatively low accuracy at the immediate ($M = 0.48$) and delayed post-tests ($M = 0.50$). Moreover, neither score was significantly different than chance-level (immediate post-test: $t(13) = 0.289$, $p = 0.777$, delayed post-test: $t(13) = 0.042$, $p = 0.967$). Thus, linguistic developmental gains were evidenced in the external, but did not reach above-chance levels.

4.3.3 Attention and Linguistic Development

For the external group, results of the linear regression models with first-pass skipping rate and overall skipping rate, the two measures significantly affected by the external attentional manipulation, as the predictor variables and gains on the learning assessment (pre-test–delayed) as the predicted variable revealed that neither measure was a significant predictor of L2 linguistic development (first-pass skipping rate: $F(1, 19) = 0.072$, $p = 0.791$; overall skipping rate: $F(1, 19) = 0.156$, $p = 0.697$). In sum, no direct relationship between attention and L2 development was evidenced.

4.3.4 Summary: External Group Results

Taken together the results for the external group suggest that attention was allocated to the target form as compared to a neutral within-subjects baseline block of trials. This was evidenced through reduced first-pass and overall skipping rates during the experimental block (when the pronoun was turned red) as compared to the within-subjects baseline block (where there was no manipulation of attention). With regard to learning, results indicate that no practical learning effect was found. While accuracy gains appear to have taken place relative to the pre-test, the accuracy scores on the immediate post-test

and the delayed post-test are not significantly different than chance. Lastly, there does not appear to be a clear, direct relationship between attentional allocation (as measured by first-pass skipping rate or by overall skipping rate) and L2 development.

4.4 Internal Attentional Condition

4.4.1 Attentional Allocation

The internal and control groups' means for the eye-tracking measures used to assess attention are displayed in Table 8[1]. The following descriptive patterns were observed in the data for the attentional manipulation trials (where SI practice was employed) relative to the within-subjects baseline trials (where no manipulation of attention was employed): (a) gaze duration slightly increased, (b) total time *greatly* increased (c) first-pass skipping rate decreased, and (d) overall skipping rate decreased.

[1] As a reminder to the reader, the same control group was compared to both the external and internal group. Thus, the means displayed for the control group in Table 6 and Table 7 above are reported again in Table 8 and Table 9 for ease of comparison with the internal group's means.

Table 8

Descriptive Results from Eye-tracking Measures for the Internal Attentional Condition

Group	*N*	Gaze Duration (ms)		Total Time (ms)		First-pass Skipping Rate (%)		Overall Skipping Rate (%)	
		M (SD)		*M (SD)*		*M (SD)*		*M (SD)*	
		Baseline Block	Experimental Block	Baseline Block	Experimental Block	Baseline Block	Experimental Block	Baseline Block	Experimental Block
Internal	20	244 (49)	274 (91)	368 (157)	490 (170)	80.33 (11.54)	70.32 (17.61)	44.67 (27.15)	30.83 (25.23)
Control	14	276 (87)	254 (69)	358 (158)	333 (153)	73.57 (22.78)	76.90 (18.74)	43.33 (23.17)	47.34 (18.77)

Note. ms = milliseconds. For ease of comparison the same control group data is presented here as was presented above in Table 6.

For the internal group, the duration-based measures of gaze duration and total time were submitted to separate 2 x 2 repeated-measures ANOVAs. The ANOVA conducted on gaze duration revealed no significant main effects (Block: $F(1,31) = .075$, $p = 0.786$, $\eta^2 = 0.002$, Group: $F(1,31) = 0.073$, $p = 0.789$, $\eta^2 = 0.002$) or interactions (Block x Group: $F(1,31) = 2.935$, $p = 0.097$, $\eta^2 = 0.086$)—see Figure 13. Results of the 2 x 2 repeated measures ANOVA conducted on total time, however, revealed a trend to a significant main effect for Block ($F(1,32) = 4.124$, $p = 0.051$, $\eta^2 = 0.114$) and a significant interaction between Block and Group ($F(1,32) = 9.348$, $p = 0.004$, $\eta^2 = 0.226$), but no main effect of Group ($F(1,32)$ 2.70, $p = 0.109$, $\eta^2 = 0.078$)—see Figure 14. Follow up repeated-measures ANOVAs within each group (internal and control) confirmed that total time significantly increased relative to the within-subjects baseline for the internal group ($F(1,19) = 13.408$, $p = 0.002$, $\eta^2 = 0.414$) but not for the control group ($F(1,13) = 0.599$, $p = 0.453$, $\eta^2 = 0.044$). Given this finding, attentional allocation appears to be affected by the internal attentional manipulation, as evidenced by a change in total time spent fixating the target form.

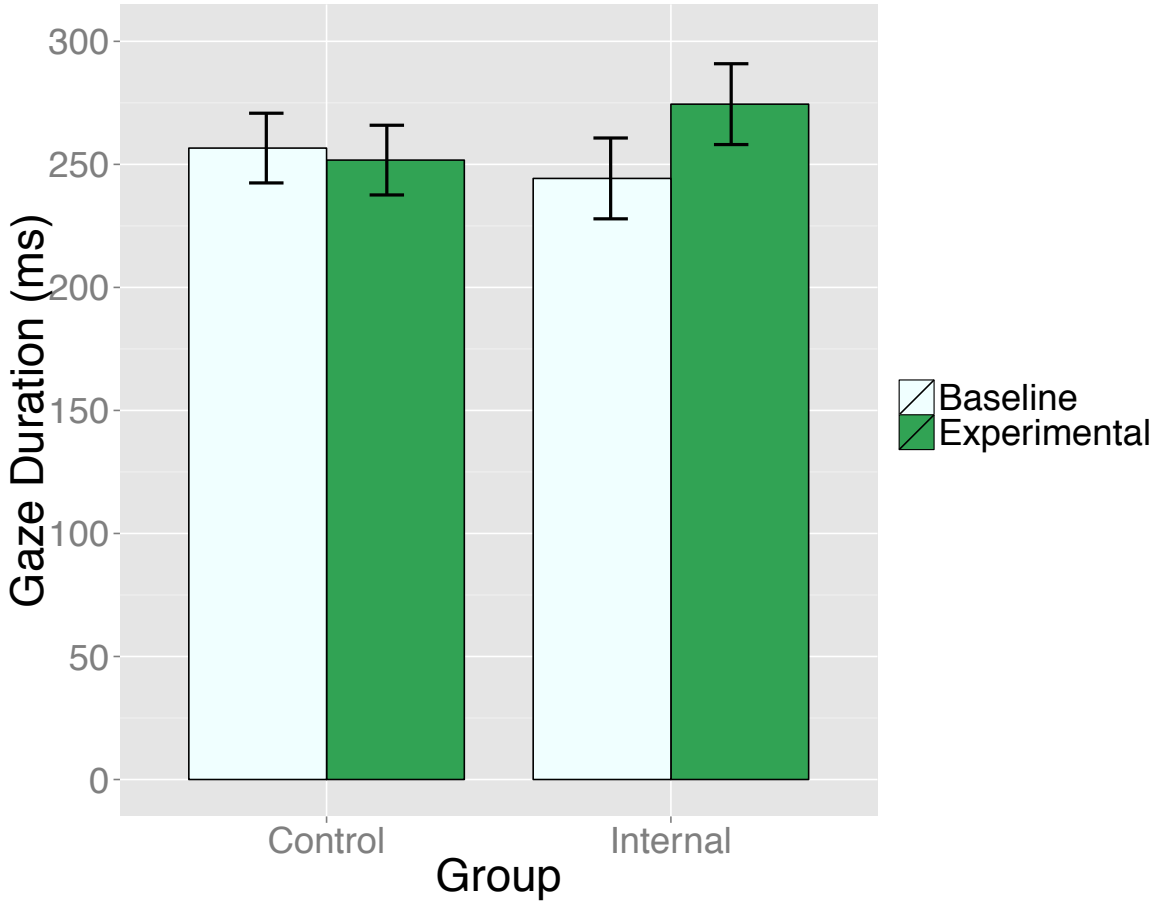

Figure 13. Gaze duration in milliseconds on the direct-object pronoun. Grouped bars represent data from separate groups (control and internal). The lighter shaded bar represents data from the within-subjects baseline block and the darker shaded bar represents data from the experimental block. Error bars represent within-subjects standard error.

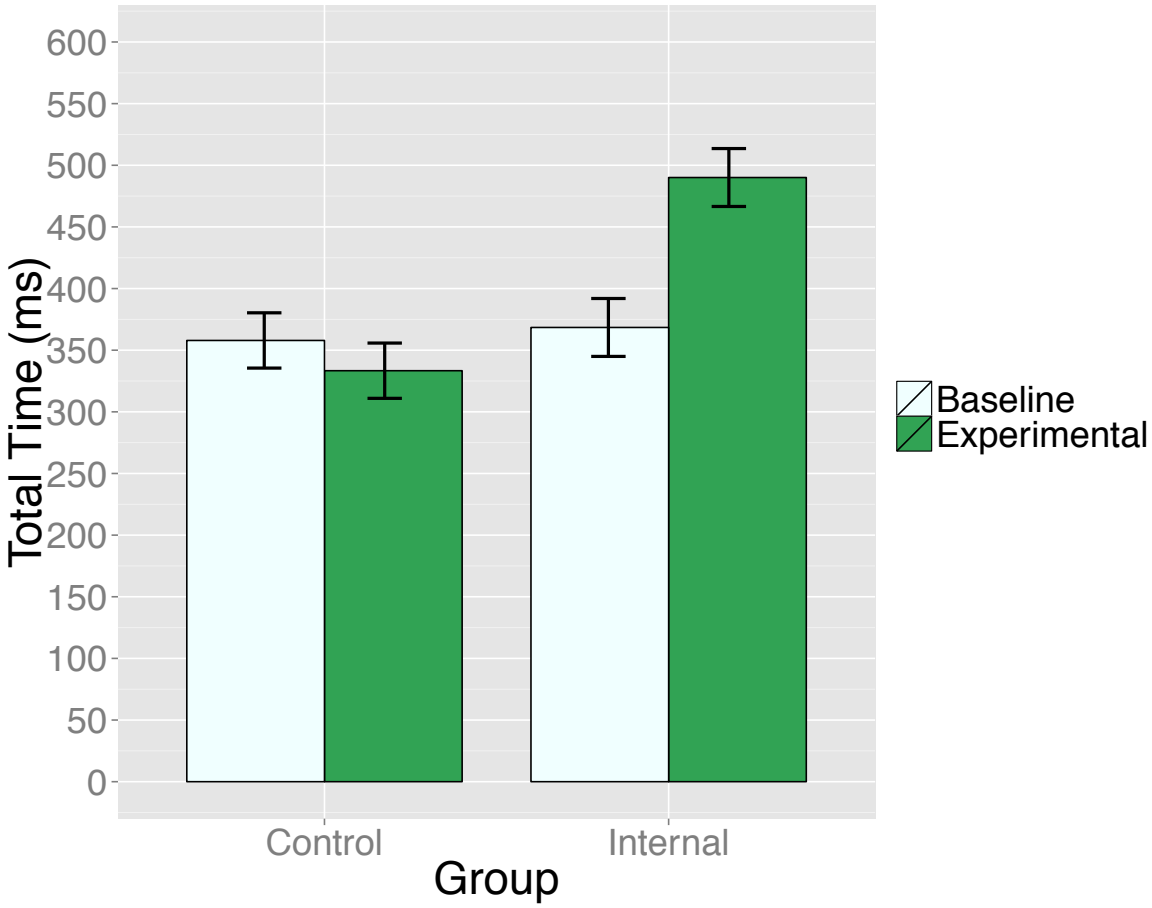

Figure 14. Total time in milliseconds on the direct-object pronoun. Grouped bars represent data from separate groups (control and internal). The lighter shaded bar represents data from the within-subjects baseline block and the darker shaded bar represents data from the experimental block. Error bars represent within-subjects standard error.

The quantity-based measures of first-pass skipping rate and overall skipping rate were also submitted to separate 2 x 2 repeated-measures ANOVAs. The results from the ANOVA conducted on first-pass skipping rate revealed a significant Block by Group interaction ($F(1,32) = 4.212$, $p = 0.048$, $\eta^2 = 0.116$) but no main effects (Block: $F(1,32) = 1.056$, $p = 0.312$, $\eta^2 = 0.032$; Group: $F(1,32) < 0.001$, $p = 0.987$, $\eta^2 < 0.001$). Follow up

repeated-measures ANOVAs within each group (internal and control) confirmed that first-pass skipping rate significantly decreased for the internal group on the experimental block relative to the within-subjects baseline block ($F(1,19) = 7.186$, $p = 0.015$, $\eta^2 = 0.274$) but not for the control group—as reported above (see Figure 15). Similarly, results from the ANOVA conducted on overall skipping rate yielded a significant Block by Group interaction ($F(1,32) = 5.470$, $p = 0.026$, $\eta^2 = 0.146$), but no main effects (Block: $F(1,32) = 1.902$, $p = 0.177$, $\eta^2 = 0.056$; Group: $F(1,32) = 0.922$, $p = 0.344$, $\eta^2 = 0.028$). Again, follow up repeated-measures ANOVAs within each group (internal and control) confirmed that overall skipping rate significantly decreased for the internal group on the experimental block relative to the within-subjects baseline block ($F(1,19) = 7.676$, $p = 0.012$, $\eta^2 = 0.288$) but did not do so for the control group—as reported above (see Figure 16). Thus, attentional allocation was affected by the internal manipulation as evidenced by the significant decreases in first-pass and overall skipping rate within the internal group.

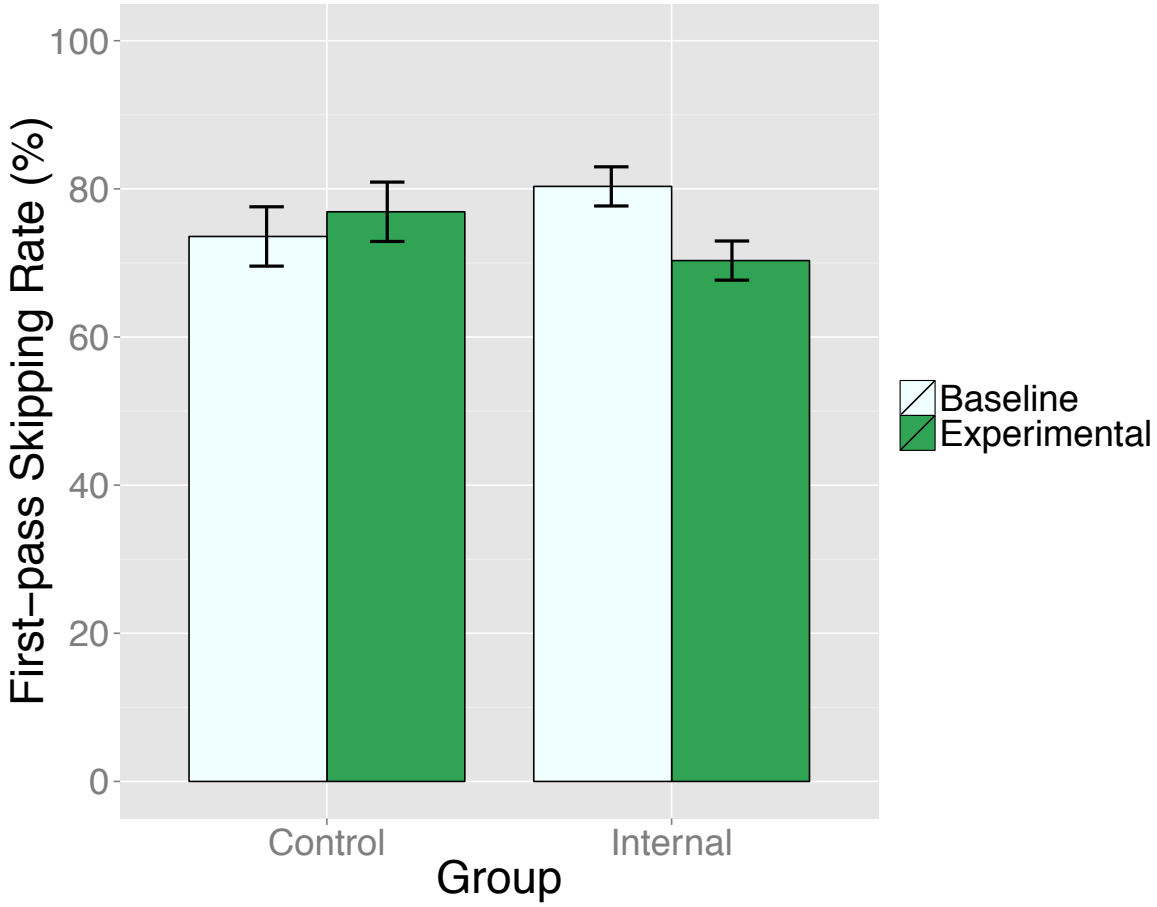

Figure 15. First-pass skipping rate of the direct-object pronoun. Grouped bars represent data from separate groups (control and internal). The lighter shaded bar represents data from the within-subjects baseline block and the darker shaded bar

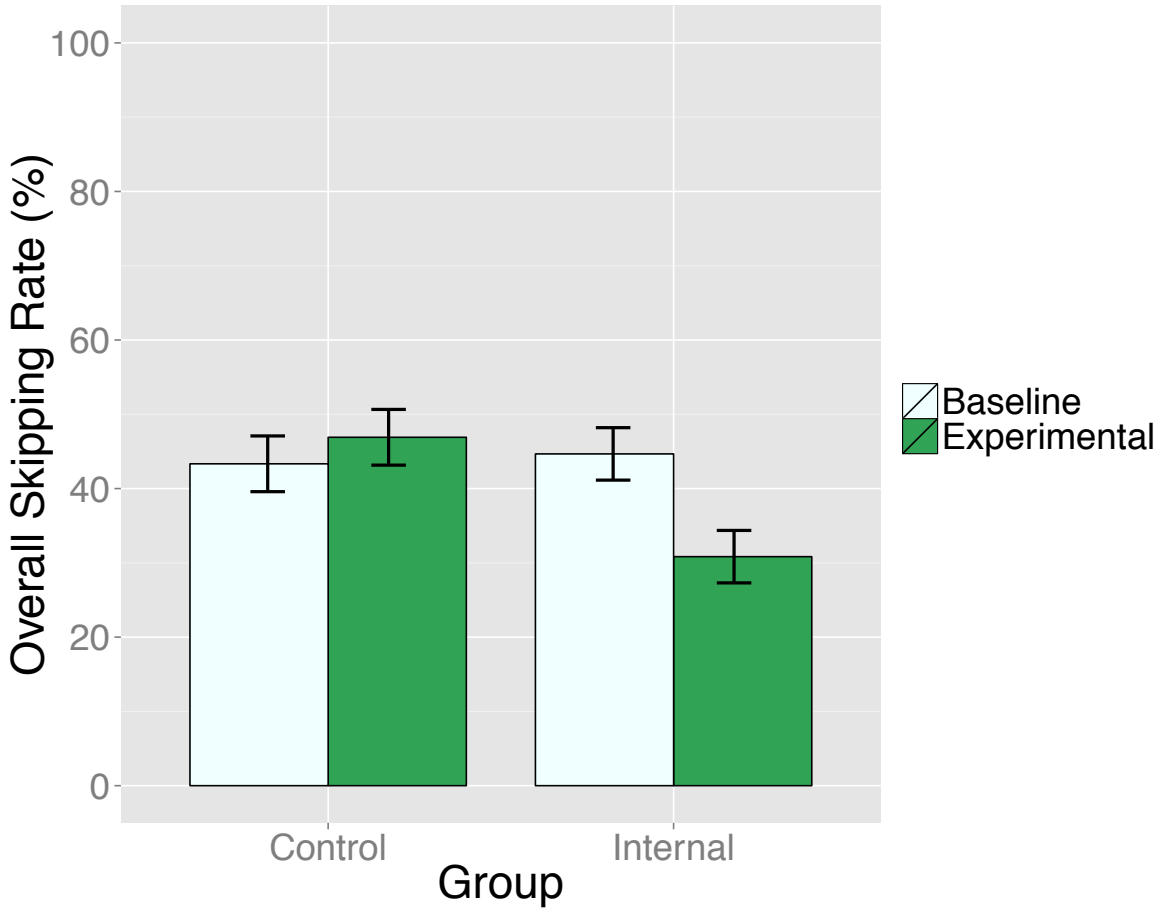

Figure 16. Overall skipping rate of the direct-object pronoun. Grouped bars represent data from separate groups (control and internal). The lighter shaded bar represents data from the within-subjects baseline block and the darker shaded bar represents

4.4.2 Linguistic Development

Group means for the pre-test, immediate and delayed post-tests used to assess L2 linguistic development of the direct object pronoun for the internal group and control group are displayed in Table 9. Descriptively, we observed that accuracy greatly increased from pre-test to immediate post-test and remained at this high value on the delayed post-test. Greenhouse-Geisser corrected results of the 3 x 2 repeated measures ANOVA that

assessed linguistic development yielded a significant main effect for Time ($F(2,64) = 58.290$, $p < 0.001$, $\eta^2 = 0.646$), a significant main effect for Group ($F(1,32) = 20.034$, $p < 0.001$, $\eta^2 = 0.385$) and a significant Time by Group interaction ($F(2,64) = 17.617$, $p < 0.001$, $\eta^2 = 0.355$). Follow up repeated-measures ANOVAs conducted within each group (internal and control) revealed a main effect for Time within the internal group ($F(2,38) = 102.348$, $p < 0.001$, $\eta^2 = 0.843$) and within the control group—but as reported above Bonferroni-corrected pairwise comparisons revealed that the accuracy scores at the immediate and delayed post-tests for the control group were not significantly different from their pre-test score. Conversely, for the internal group, Bonferroni-corrected pairwise comparisons showed that the gains from the pre-test to immediate post-test ($p < 0.001$, $d = 3.61$) and from pre-test to delayed post-test ($p < 0.001$, $d = 3.48$) were significant and the decrease from immediate to delayed was not significant ($p = 0.557$). These results suggest that developmental gains were evidenced as a result of the internal manipulation and that these gains persisted two weeks later (see Figure 17).

Table 9

Accuracy on Learning Assessment Measure for Internal Attentional Condition

Group	*N*	Pre	Immediate	Delayed
		M (*SD*)	*M* (*SD*)	*M* (*SD*)
Internal	20	.24 (.16)	.87 (.18)	.85 (.14)
Control Group	14	.31 (.16)	.48 (.28)	.50 (.28)

Note. For ease of comparison the same control group data is presented here as was presented above in Table 7.

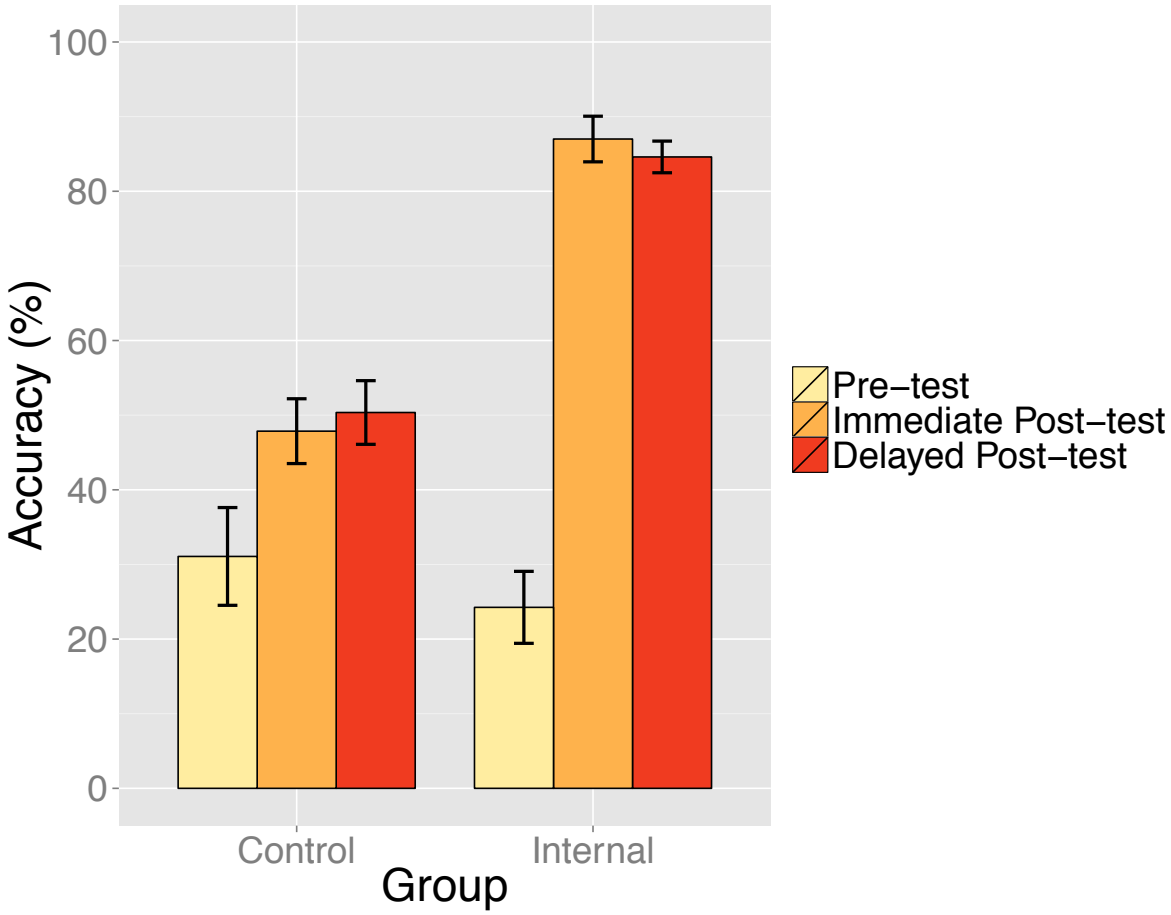

Figure 17. Accuracy on the learning assessment. Grouped bars represent data from separate groups (control and internal) at pre-test, immediate post-test and delayed post-test ordered as such from left to right. Error bars represent within subjects

Additionally, in order to assess whether the level of accuracy obtained at the immediate post-test and delayed post-tests were significantly different than chance, post-hoc one-sample t-tests were conducted (with the test-value set to 0.5) and revealed that the score for the internal group at the immediate post-test ($t(19) = 0.454$, $p < 0.001$) and

delayed post-test ($t(19) = 10.697$, $p < 0.001$) were indeed significantly higher than chance levels[2].

Lastly, a post-hoc ANOVA was performed comparing the internal and control groups' accuracy scores from the immediate and delayed post-tests to ensure that the learning effects found within the internal group were not just due to exposure to the target form. This ANOVA revealed that the internal group performed significantly more accurately than the control group at both the immediate post-test ($F(1,32) = 25.465$, $p < 0.001$, $\eta^2 = 0.443$) and at the delayed post-test ($F(1,32) = 21.729$, $p < 0.001$, $\eta^2 = 0.404$). Thus, taken together the results indicate that L2 linguistic development took place at the immediate post-test and was durable two weeks later for the internal group. Furthermore, the internal group's accuracy scores were significantly different than chance-levels and significantly different than the control group.

4.4.3 Attention and Linguistic Development

For the internal group, results of the simple linear regression models with total time, first-pass skipping rate and overall skipping rate as the predictor variables (i.e., the measures that were significantly affected by the internal manipulation) and gains on the learning assessment (pre-test–delayed) as the predicted variable revealed that none of these measures were a significant predictor of L2 linguistic development (total time: $F(1, 18) = 0.475$, $p = 0.500$; first-pass skipping rate: $F(1, 18) = 1.035$, $p = 0.322$; overall skipping rate: $F(1, 18) = 0.032$, $p = 0.859$).

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[2] As reported above, and presented again here for ease of comparison, the control group did not evidence accuracy scores higher than chance-levels at the immediate post-test ($t(13) = 0.289$, $p = 0.777$) or the delayed post-test ($t(13) = 0.042$, $p = 0.967$).

4.4.4 Summary: Internal Group Results

Taken together the results for the internal group suggest that attention was allocated to the target form on the experimental block as compared to a neutral within-subjects baseline block of trials. This was evidenced through increased total time fixating the pronoun, and through reduced first-pass and overall skipping rates during the internal manipulation (when structured input practice was employed) as compared to the within-subjects baseline trials (where there was no manipulation of attention). With regard to learning, results indicate a robust learning effect with accuracy gains evidenced at the immediate and the delayed post-tests. These scores were significantly different than chance, and significantly different than the control group. Furthermore, there was no decay in accuracy when comparing the immediate and delayed post-tests, suggesting that the linguistic development as a result of the internal manipulation appears to be durable. Lastly, there does not appear to be a clear, direct relationship between attentional allocation (as measured by total time, by first-pass skipping rate or by overall skipping rate) and L2 linguistic development for the internal group.

5. DISCUSSION AND CONCLUSION

5.1 Introduction

This dissertation was designed to examine how external and internal manipulations of attention affect attentional allocation, bring about L2 linguistic development of a novel morphosyntactic structure and whether a relationship between attentional allocation and L2 linguistic development could be uncovered. These questions were answered through the use of a concurrent measure of overt attention (eye-tracking) employed during two separate L2 instructional interventions. In what follows, I will discuss the results from each of the attentional manipulations separately with regard to the research questions and hypotheses outlined in Chapter 2 and situate the findings within the context of relevant L2 development research. The external manipulation will be discussed in § 5.2 and the internal manipulation will be discussed in § 5.3. Furthermore, I will provide a more general discussion of the results as a whole in § 5.4. In this general discussion, I will refer back to the open issues in L2 research highlighted in Chapter 2 in § 5.4.1, as well as discuss the effects of task-essential practice within the present study in § 5.4.2. Additionally, I will explain how these findings may be applied to the second language classroom context in § 5.4.3 as well as discuss how these results relate to research in cognitive science on attention in § 5.4.4. Finally, I describe the limitations of the present study and identify suggestions for future research in § 5.5 and end the chapter with conclusions regarding the dissertation in § 5.6.

5.2 External Manipulation of Attention

5.2.1 Research Question 1A: Attentional Allocation

Results from the external attentional manipulation, where textual input enhancement was provided to learners (turning the pronoun red in stimuli sentences), indicate that attentional allocation was indeed manipulated by this external manipulation. This was evident in the eye-movement record as the two quantity-based measures examined were significantly affected by this manipulation and evidenced large effect sizes. That is, first-pass skipping rate (i.e., the percentage of trials where the pronoun was skipped over on participants' first pass at reading the stimuli sentence from left to right) and overall skipping rate (i.e., the percentage of trials where the pronoun was skipped over all together, on the first pass or on subsequent passes) significantly decreased on the block where this manipulation was employed as compared to the baseline block with no manipulation of attention (i.e., where the pronoun was presented in black font just as the rest of the stimuli sentence). As an effect was found in the two measures that quantify the number of fixations participants made on the form and not in either of the duration-based measures (that quantify the amount of time spent looking at the form), it can be concluded that this manipulation caused participants to look at the form more often but not necessarily for any longer. Taken together, these results confirm Hypothesis 1A, in that learners do indeed allocate more attention to the target form.

In order to probe whether automatic or controlled cognitive processes were differentially affected by the external manipulation, we can compare the effect sizes (i.e., the amount of variance accounted for when comparing attentional allocation on the baseline block to the experimental block) yielded by the two quantity based-measures

examined here. To remind the reader, first-pass skipping rate is thought to index earlier, more automatic processes such as such as sensory processing and motor control whereas overall skipping rate is thought to index later, more controlled processes, such as semantic integration or ambiguity resolution (as this includes fixations that were the result of regressions back to the pronoun). While both measures yielded sizeable effects, first-pass skipping rate was able to account for *more* variance in the change in attentional allocation between the two blocks than overall skipping rate (first-pass skipping rate: η^2 = 0.714 and overall skipping-rate: η^2 = 0.579). This difference in effect size might suggest that the external manipulation is differentially affecting early, automatic cognitive processes, more so than later, more controlled processes. To further this argument, I examined the relationship between first-pass skipping rate and overall skipping rate through a post-hoc correlation analyses, which revealed that the two measures were strongly, positively correlated with one another (r = 0.701, p = 0.005). Thus, further suggesting that the external manipulation may differentially affect automatic attentional processes,

Regarding previous research on IE, these findings provided direct evidence that textual IE does indeed significantly manipulate learners' attention, at least with regard to how often participants fixate the target form. These results are at least partially in line with Winke (2013), which is the most relevant study for direct comparison. Insofar as Winke also reported a meaningful change in her "number-of-visits" variable (pg. 335)—i.e., the number of times the target form was fixated, the inverse of overall skipping rate reported here. Winke reported an increase in number of visits when comparing non-enhanced to enhanced forms. Note, however, that this effect did not reach statistical significance, but did

produce a medium effect (r^2 = 0.25, where r^2 is also a measure of variance explained, similar to η^2). Thus, results from the present study as well as the results from Winke provide converging evidence that external manipulations of attention lead learners to look at target forms more often. However, the findings reported here diverge from those reported in Winke in that neither of the duration-based measures examined in the current study (gaze duration and total time) were significantly affected by IE. Conversely, the two measures (total time and re-reading time) examined in Winke's study did evidence a significant increase in duration when comparing non-enhanced to enhanced forms.

Note, however that an important difference between the design of the current project and that of Winke (2013) exists: In Winke's design (a conceptual replication of Lee, 2007), participants read texts flooded with enhanced and non-enhanced forms. On the other hand, in the present study, participants engaged in meaningful practice with the L2. However, the task in which IE was embedded was not task-essential practice with the target form (i.e., participants did not have to interpret the form to complete the task—see § 5.4.2 for further discussion on this topic). Thus, the interaction between non-task essential practice may have induced longer dwell times on other information in the sentences (such as information about the time when the action occurred or the place where the action occurred) and consequently, shorter dwell time on the target form in the present study as compared to Winke.

5.2.2 Research Question 1B: Linguistic Development

Regarding learning, the results for the external attentional manipulation suggest that this manipulation did not bring about clear L2 linguistic development. Although the change from pre-test to immediate post-test for this group was statistically significant, the

score at the immediate post-test was not significantly different than chance-levels and not significantly different than the control group at either the immediate or delayed post-test. Taken together, these findings appear to suggest that initial L2 linguistic development of the form may have taken place under this attentional manipulation, but development was not robust enough for participants to distinguish themselves from chance on the immediate test, thus results do not support Hypothesis 1B.

However, findings from the delayed post-test for this condition warrant further discussion. More specifically, based on the large effect size found when comparing pre-test to delayed (d = 1.35), combined with the trend to a significant difference when comparing accuracy at the delayed post-test to chance-levels (p = 0.073), one could argue that knowledge has developed at the delayed post-test as a result of the external manipulation. However, given that the comparison to chance was only a trend to a significant difference, this finding is tentative and suggests that while some knowledge has developed, it might not be easily utilized when faced with the assessment employed in the present study.

This tentative finding may be explained by the implicit nature of the training conditions to which these participants were exposed. More specifically, as participants were not exposed to any sort of explicit information about the form before they began the experiment, and the practice they completed was not task-essential (i.e., they did not have to specifically attend to the target form to respond correctly to the task), this was a relatively implicit training condition. Moreover, previous research has shown that implicit training conditions may lead to the acquisition of implicit knowledge (Rebuschat, 2013; Rebuschat & Williams, 2012; Rebuschat, Hamrick, Sachs, Riestenberg, & Ziegler, 2013), which may take longer to develop. Given this, it is not surprising that the increase in

accuracy evidenced at the delayed post-test (average change from pre-test to delayed: .38) is larger than that evidenced at the immediate post-test (average change from pre-test to immediate: 0.28). Therefore, it may be the case that a two-week period with no additional exposure to the target form after a short, implicit training condition did not foment the right conditions for *robust* L2 development to take place.

Another potential explanation for the low level accuracy obtained by this group may be related to the fact that this group is evidencing restructuring of their second language system. That is, we can speculate that participants may have approached the task adhering to the First Noun Principle (VanPatten, 2004) and therefore may have assumed that the first noun-like element they encountered (in this case the pronoun 'lo' or 'la') was the subject. This hypothesis is in fact confirmed by comparing performance on the pre-test to chance. Results of a post-hoc one sample *t*-test with the test value set to 0.50 revealed that participants performed significantly lower than chance-levels ($t(20) = 8.113$, $p < 0.001$), indicating that they consistently responded following a particular strategy. Due to the nature of the items implemented in this study, we know that the strategy participants adhered to is in fact the First Noun Principle, that is they are interpreting the theme in the sentence as the agent. Thus, as this is a relatively implicit training condition, these participants may still be in the process of hypothesis testing and rule formation and may have not fully restructured their interlanguage system to reflect the correct theta-role assignment. In this light, if we consider participant scores on the pre-test (which were significantly different than chance-levels) to reflect adherence to an incorrect rule, the accuracy scores evidenced at the immediate and delayed post-test (which were not different than chance- levels) suggest that participants are no longer adhering to the First

Noun Principle and that at least some of the time are considering other alternatives, i.e., that the pronoun may represent some element other than the subject. Given this interpretation of the results, L2 development appears to have taken place under the external manipulation, albeit at a slower rate, which cannot be fully captured after limited practice.

With regard to previous research on L2 development as a result of IE, the present study adds to this body of research by showing that developmental gains take place for these participants but they do not develop knowledge at higher than chance-levels. This is one of few studies to employ input enhancement embedded within an L2 *practice* paradigm (as compared to a paradigm where participants read texts flooded with enhanced forms) and consequently, the present project has uniquely contributed to the body of research on IE in L2 acquisition by providing an example of a practice paradigm through which IE can be implemented. That said, however, it should be noted that the nature of the task itself may have led to the weak learning effect. That is, the fact that the practice task was not task-essential may explain the lack of a meaningful effect. The use of input enhancement in a task that does not foster further processing of the input may lead learners to look at the enhanced form more often but does not appear to bring about robust linguistic development of that form, a fact that appears to fall in line with Robinson's views on attention, awareness and L2 development (1995, 2003).

5.2.3 Research Question 1C: Attention and Linguistic Development

Regarding the relationship between attention and learning for the external attentional condition, results indicate that no clear direct relationship was found. This is not entirely surprising considering that the developmental gains evidenced were small and

not statistically significant. Thus, these results do not support Hypothesis 1C. Regarding previous research, these results are in line with those reported in Winke (2013; the only study to date to employ IE and eye-tracking as a concurrent measure of learner attention) in the following ways: (a) development did not take place as a result of practice with external manipulations of attention through textual enhancement of target forms, and (b) no direct relationship between attention as measured by eye-movements and learning was evident.

5.3 Internal Manipulation of Attention

5.3.1 Research Question 2A: Attentional Allocation

Results from the internal attentional condition, where Structured Input practice was employed (the presentation of two contrasting images that direct the learners attention to the target form before reading the stimuli sentence), indicate that attentional allocation was indeed affected by this internal manipulation. This was evident in the eye-movement record as the two quantity-based measures of eye-movements and one of the duration-based measures was significantly affected by this manipulation. With regard to the quantity-based measures, first-pass skipping rate (i.e., the percentage of trials where the pronoun was skipped over on participants' first pass at reading the stimuli sentence from left to right) and overall skipping rate (i.e., the percentage of trials where the pronoun is skipped over all together, on the first pass or on subsequent passes) significantly decreased on the block where this manipulation was employed as compared to the baseline block, with no manipulation of attention (i.e., where there were no images presented before the stimuli sentence) and yielded medium effect sizes (first-pass skipping rate: $\eta^2 = 0.274$,

overall-skipping rate: $\eta^2 = 0.288$). Thus, this manipulation caused learners to look at the direct object pronoun more often.

Regarding the quantity-based measure of total time (i.e., the total amount of time participants spent looking at the pronoun—including fixations that were the result of regressing back to the pronoun), a significant increase in this measure was evidenced on the block where the manipulation was employed as compared to the within-subjects baseline block, yielding a large effect size ($\eta^2 = 0.414$). Thus, taken together, the results from the quantity-based and duration-based eye-tracking measures indicate that the internal attentional manipulation caused participants to look at the pronoun more often *and for longer* with a larger effect evidenced for the quantity-based measures. Overall, these results support Hypothesis 2A, in that the internal manipulation of attention employed here does lead learners to allocate more attention to the target form.

Additionally, an examination of the pattern of results with regard to whether the eye-tracking measures are thought to index early, automatic cognitive processes or later, more controlled processes, suggests that this internal manipulation taps into both kinds of processes and in fact may affect controlled processes to a greater extent, as both overall skipping rate and total time were significantly affected by this manipulation. Furthermore, the relatively large effect size for total time as compared to either of the skipping rates, indicates that this measure explained more variance in the change in attentional allocation from the baseline to the experimental block for this condition. Therefore, it appears that once learners allocated their attentional resources to the target form they dwelled on it or returned to it in order to extract the linguistic information necessary to comprehend the sentence in its entirety, thus the condition promoted further processing of the target form.

With regard to previous research on SI practice, the current study provides novel direct evidence that the manipulation causes learners to direct their attention to the linguistic target form. Whereas previous research has shown that this type of manipulation results in learning (e.g., Benati, 2004; Farley, 2004; Sanz & Morgan-Short, 2004; VanPatten & Oikkenon, 1996; Wong, 2004) and has shown that development takes place rather quickly as a result of this type of manipulation (e.g., Fernandez, 2008; Henry et al., 2009; VanPatten & Borst, 2012), the current results add an additional layer of evidence in support of SI. That is, the results provide evidence that this internal manipulation of attention causes learners to direct their attention to the target form by looking at it more often and for longer as compared to other types of practice and may differentially affect later, more controlled processes. Thus, we have provided additional, unique insight into how learners' cognitive processes are affected by SI practice.

5.3.2 Research Question 2B: Linguistic Development

Concerning L2 development, the results for the internal attentional manipulation suggest that this manipulation did indeed bring about L2 linguistic development. The gains in accuracy from pre-test to immediate post-test and pre-test to delayed post-test for this group were significant and yielded large effect sizes (pre-test to immediate post-test: d = 3.61, pre-test to delayed post-test: d = 3.48), suggesting that the change in scores can be attributed to this internal manipulation of attention. Furthermore, both scores were significantly greater than chance-levels. Additionally, scores obtained at both time points were significantly greater than the scores obtained by the control group with these comparison yielding large effect sizes (immediate post-test: η^2 = 0.443 and delayed post-tests: η^2 = 0.404). Moreover, no significant change in accuracy was found between the

immediate and delayed post-test. Taken together, these findings suggest that robust, practically significant and durable L2 linguistic development took place as a result of the internal attentional manipulation, thus, these results confirm Hypothesis 2B.

With regard to previous research on SI practice and L2 development (e.g., Benati, 2004; Farley, 2004; Sanz & Morgan-Short, 2004; VanPatten & Oikkenon, 1996; Wong, 2004), the present study adds to the body of literature confirming that SI practice with morphosyntactic target forms leads to development of those forms. Furthermore, as we did not provide learners with explicit information about the form and they had not yet been exposed to it in their courses, we have provided additional evidence that, at least with some linguistic structures, explicit information is not necessary for linguistic development to take place. Overall, these results appear to support the positive effects of SI practice without explicit information on the development of morphosyntax.

5.3.3 Research Question 2C: Attention and Linguistic Development

Given that this internal manipulation of attention prompted learners to allocate their attention to the target form and brought about a robust learning effect it is surprising that no relationship between attentional allocation and learning was found in this condition. One potential explanation for this lack of an effect is that under this condition, participants may exhibit development rather quickly (as has been shown in previous processing instruction research). That said, once they have learned the form-meaning mapping (i.e., *lo*, 'him' maps onto theme$_{masculine}$ and *la*, 'her' maps onto theme$_{feminine}$), participants may not need to allocate as much attention to the target form to extract the linguistic information in order to correctly respond to the task at hand. Thus, in order to more fully explore this possibility, I conducted a post-hoc examination of a subset of the

eye-movement record that only included data from trials in the experimental block up until the point where participants met a specific learning criterion. Following VanPatten and colleagues (e.g., Fernandez, 2008; Henry et al., 2009; VanPatten & Borst, 2012), the learning criterion was as set so that the form was considered "learned" after a participant had correctly responded to three consecutive trials. Subsequently, the eye-tracking measures of total time and overall skipping rate were re-calculated for this subset of trials for participants in the internal attentional manipulation group and submitted to correlation analyses along with the accuracy scores on the immediate and delayed post-tests for those participants who evidenced learning[3]. Results of this analysis indicated a trend to a statistically significant, medium-sized negative correlation between overall skipping rate and accuracy on the delayed post-test (r = -0.449, p = 0.062), indicating that participants who skipped the pronoun less often on trials before they reached learning criterion, exhibited a higher accuracy score on the delayed post-test.[4] As this effect did not reach statistical significance, its interpretation is tentative, however, it may suggest that more attention, at least as measured by overall skipping rate leads to more development in this condition. Thus, although results from the original analysis do not support Hypothesis 2C, the tentative findings from this post-hoc analysis potentially do support the hypothesis that attention allocated to the target form can account for linguistic development of that form.

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[3] For this post-hoc analysis 18 of the original 20 participants were included as there were two participants who scored below chance on the delayed post-test.

[4] Correlation results indicated weak non-significant relationships for total time and immediate (r = .260, p = .331) and delayed (r = .058, p = .832) accuracy scores. Similar results were observed for the relationship between overall skipping rate and the immediate post-test accuracy scores (r = -.239, p = .340).

5.4 General Discussion

5.4.1 Open Issues in Second Language Research

In Chapter 2, I identified various open questions within the field of L2 research related to attention and L2 development. I have repeated them below for ease of presentation. In what follows, I will outline how the results of the present study contribute to answering these open questions.

(a) Does attention to a target form result in learning of that target form?

(b) More specifically, does attention to rule-based grammatical features result in learning of those features?

(c) Does textual input enhancement lead learners to allocate attention to target forms?

(d) Does structured input practice lead learners to allocate attention to target forms?

Regarding questions (a) and (b), the present study has contributed to previous research in providing indirect evidence that attention allocated to a target form does indeed lead to linguistic development of that form. While the hypothesized direct relationship between attention and learning was not borne out by the data examined here, if we consider the results for the internal and external groups, we have shown that attentional allocation was affected by these manipulations and that L2 linguistic development of the target form took place (albeit, to a lesser extent for the external group). Thus, we can argue that overt attention allocated to the target-form can, at least in part, account for the development that took place in the two groups. However these results

appear to confirm Schmidt's notion that attention alone cannot account for linguistic development and that other factors may be at play, such as awareness. If this were the case, these findings would align nicely with those that have investigated the relationships between attention, awareness and vocabulary development (Godfroid et al., 2013; Godfroid et al., 2010; Godfroid & Schmidtke, 2013) and the one study that has investigated morphological development (Godfroid & Uggen, 2013) with a reliable concurrent measure of attention.

Turning to questions (c) and (d), results from the present study strongly suggest that learner attention is affected by these instructional interventions. Indeed, learner attention was significantly directed to the target form more often as compared to the within-subjects baseline by both of the instructional interventions employed in the current study. Thus, the present study has contributed unique evidence to the strand of L2 development research focusing on the effectiveness of these instructional interventions by utilizing the methodology of eye-tracking. That is, we have provided a direct measure of how learners' attentional allocation is affected by these instructional interventions. This evidence is novel in that research on IE has only just begun to use concurrent measures such as eye-tracking (Winke, 2013) and research on SI has not yet included this type of measure in their experimental design.

5.4.2 Task-essential Practice

A crucial and inherent difference between the external and internal manipulations implemented in the present study was the nature of the language practice that participants in each condition completed. That is, in order to design a task that tapped into external attentional mechanisms, we employed a purely external manipulation of attention through

the use of IE in non-task essential practice (i.e., where participants did not need to interpret the target form in order to correctly respond to the task). On the other hand, an inherent characteristic of SI practice, our internal attentional manipulation, is that this type of practice is necessarily task-essential. Thus, the fact that the external attentional condition was [-task essential] and the internal attentional condition was [+task essential] may explain some of the qualitative differences in attentional allocation and learning that were apparent in the results. Interestingly, we see that the purely external manipulation of attention, which was [-task essential], did indeed affect attentional allocation as indexed by eye-movements but only brought about weak linguistic development of the target form. Considering that results from the internal manipulation of attention, which was [+ task essential] affected attentional allocation and also brought about linguistic development, future research should develop a paradigm that includes IE embedded in task essential practice to explore the effects of external and internal manipulations of attention working in conjunction and thus affecting both attentional systems.

5.4.3 Extending Findings to the Classroom

The results of the present study are informative for decisions regarding the development and design of pedagogical materials such as textbooks, homework activities and in class input presentation materials. Regarding the use of external manipulations of attention through textual input enhancement, there are various potential applications for this type of manipulation. First, as this manipulation is relatively flexible it can be employed in text books in either passages of texts, or in standard communicative activities through the enhancement of specific linguistic structures. However, the results of the present study speak most directly to the use of IE embedded in interactive language

practice at a sentential level, which could be delivered to learners via online homework platforms. As noted above, though, the nature of the practice appears to play an important role in whether linguistic development takes place, that is, although participants may allocate attention to the target when it is enhanced, they may not further process it and thus may not extract the relevant linguistic information or build up any sort of rule knowledge about the form or do so at a slower rate, needing extended practice. This suggests, that IE may best be suited to bring about linguistic development when embedded in task essential practice, which would change the manipulation from being a purely external manipulation of attention to one that taps into both external and internal attentional mechanisms. Thus the use of IE alone should be considered carefully when designing activities for use in the classroom, although it is not clear that the use of IE is detrimental for learners, learning affects appear to take longer to robustly manifest when embedded in non-task essential practice.

Regarding the use of internal manipulations of attention through structured input practice, the most logical practical application for this type of manipulation is to use it as practice activities that learners can complete on their own as homework. Ideally, this sort of practice can be delivered via an automated computer program that can provide synchronous feedback about the learners' responses. As this type of feedback has also been posited as crucial for benefits associated with structured input practice. Furthermore, it appears that this sort of practice, at least with regard to the morphosyntactic structure examined here, does not need to be accompanied by explicit information to bring about linguistic development of the form. Thus, providing structured input practice without

explicit information in an online computer-administered homework platform as a way to introduce learners to novel morphosyntactic structures is recommended.

5.4.4 Extending Findings to Cognitive Science

The present study has aimed to extend findings from cognitive science related to external and internal attentional mechanisms to a language paradigm. Although previous research has shown a double dissociation in dual-task experiments such that when internal attention is taxed, external attention is not affected and vice versa (Lavie et al., 2004; Pashler, 1991; Pashler, 1994), the present study has not implemented this type of dual-task design, thus we cannot directly speak to whether this type of dissociation is evident with language stimuli. However, the results of the present study appear to be generally consistent with the characterization of separable yet cooperative external and internal attentional mechanisms posited by Chun et al (2011). That is, by examining the overall pattern of eye-tracking results associated with the external manipulation of attention and those associated with the internal manipulation of attention, we have observed qualitative differences in the distribution of these results. As explained above, the external manipulation appeared to largely affect quantity-based eye-tracking measures. On the other hand, the internal manipulation, affected quantity and duration-based eye-tracking measures. Furthermore, the external manipulation affected measures thought to reflect early, automatic cognitive processes, whereas the internal manipulation, to a greater extent, affected eye-tracking measures that are thought to reflect later, controlled cognitive processes. Thus, while we do not see a complete dichotomy, with regard to the eye-movement record or the cognitive processes that the external and internal manipulations employed here tap into, we do see some qualitative differences. The fact that complete

separation is not evidenced may be due to the more complex nature of language stimuli. That said, the fact that there appears to be collaboration between these two attentional systems, as evidenced by overlaps in the pattern of results observed, is not inconsistent with Chun et al's account of external and internal attention. Thus, overall, these findings provide novel evidence with regard to how external and internal attentional mechanisms are affected by attentional manipulations implemented through language stimuli.

5.5 Limitations and Future Directions

While this study aimed to address various open questions within the field of L2 development regarding the role of attention in the learning of morphosyntax, as with any project, there are limitations. First, the logistical timing constraints imposed by the combination of the type of participants recruited (students from first-semester Spanish courses), the timing of instruction in their courses and the target form chosen, forced me to conduct the follow up session only two weeks after the initial session. If participants had been tested any later during the semester they would have already received explicit information and additional practice related to the target-form through their coursework, which would have added a confounding variable to the experimental design (i.e., uncontrolled, outside exposure to the target form). This short amount of time between sessions may have limited the findings regarding L2 development for the external group. Future research should employ a design that allows for participants to be tested multiple times up to eight weeks after the initial session.

Another potential explanation for the weak learning effect evidenced for the external group may be related to the task used to assess linguistic development used in the

present study. That is, the items participants in this group were exposed to during their training on the target form did not exactly match the critical items on the L2 learning assessment. Thus, the training conditions may not have fostered transfer-appropriate processing from one task to the other and thus may have played a role in the lack of learning effect found for the external group. Future research should consider the implementation of various learning assessment tasks that would better mirror the type of practice employed.

Lastly, while there was no direct relationship between attention and L2 linguistic development for either group, it may be the case that this relationship is moderated by other factors that have been posited as critical for successful second language development to take place. Future research should consider the interaction between attention and other cognitive variables such as working memory, or further examine how attention leads to and affects awareness (as previous research has done, e.g., Godfroid et al., 2010; Godfroid & Schmidtke, 2013). Another potentially fruitful avenue to pursue is the relationship between attention and affective variables such as motivation or anxiety (as these particular factors has been previously linked to attention by Tremblay & Gardner, 1995).

5.6 Conclusion

The results of the present study are informative for both theory and applied research in L2 acquisition. Specifically, regarding theory, it appears that internal manipulations of attention reliably bring about learning and that the external manipulation does so but at a slower rate. Thus, by directing a learner's attention to a target form through the use of internally generated information, the learner is more likely to turn that input into intake (i.e., further process the information) with a relatively brief amount of

practice. Although the direct relationship hypothesized between attention and learning was not evidenced in this study, we have provided an important additional layer of indirect evidence for a relationship between attention and learning through the use of eye-tracking in the examination of how learners interact with different instructional interventions that were designed to manipulate their attention.

Regarding instructed L2 acquisition research, the present study has contributed innovative evidence by incorporating two well-researched instructional interventions in the experimental design, and provided insight into the cognitive processes of learners when they interact with these interventions. These results should be considered in pedagogical decisions and foreign language classroom materials development.

Lastly, results from the present study have added to the body of research in the field of cognitive science by providing indirect evidence that attentional mechanisms are central to yet another type of learning; the learning of a complex naturally occurring rule-governed language system.

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APPENDICES

APPENDIX A

Sample stimuli sentences used in experimental tasks

Table 1A

List of unique sentences used as basis for complete stimuli list

	Sentence	English Translation
1	Por la mañana a las ocho, lo abraza en su cocina.	At eight in the morning, she hugs him in their kitchen.
2	Por la mañana a las ocho, la acaricia en su cocina.	At eight in the morning, he caresses her in their kitchen.
3	Por la tarde a las tres, la ahorca en el parque.	At three in the afternoon, he strangles her in the park.
4	Por la mañana a las ocho, lo ama en su sala.	At eight in the morning, she loves him in their living room.
5	Por la tarde a las tres, lo asusta en el parque.	At three in the afternoon, she scares him in the park.
6	Por la mañana a las ocho, la ataca en su sala.	At eight in the morning, he attacks her in their living room.
7	Por la tarde a las tres, la ayuda en el parque.	At three in the afternoon, he helps her in the park.
8	Por la mañana a las ocho, la besa en su sala.	At eight in the morning, he kisses her in their living room.
9	Por la noche a las ocho, lo busca en el parque.	At eight at night, she looks for him in the park.
10	Por la tarde a las tres, lo carga en el parque.	At three in the afternoon, she carries him in the park.
11	Por la tarde a las tres, lo cura en su sala.	At three in the afternoon, she heals him in their living room.
12	Por la noche a las ocho, lo despierta en su cocina.	At eight at night, she wakes him up in their kitchen.
13	Por la noche a las ocho, lo empuja en su cocina.	At eight at night, she pushes him in their kitchen.
14	Por la mañana a las ocho, la encuentra en el parque.	At eight in the morning, he finds her in the park.
15	Por la mañana a las ocho, la ensucia en su sala.	At eight in the morning, he gets her dirty in their living room.
16	Por la noche a las ocho, la escucha en su cocina.	At eight at night, he listens to her in their kitchen.
17	Por la mañana a las ocho, la extraña en el parque.	At eight in the morning, he misses her in the park.
18	Por la noche a las ocho, la golpea en su cocina.	At eight at night, he punches her in their kitchen.

APPENDIX A (CONT.)

	Sentence	English Translation
19	Por la mañana a las ocho, lo lastima en el parque.	At eight in the morning, she hurts him in the park.
20	Por la noche a las ocho, lo limpia en su sala.	At eight at night, she cleans him in their living room.
21	Por la tarde a las tres, la llama en su cocina.	At three in the afternoon, he calls her in their kitchen.
22	Por la noche a las ocho, la mira en su cocina.	At eight at night, he looks at her in their kitchen.
23	Por la tarde a las tres, lo patea en su sala.	At three in the afternoon, she kicks him in their living room.
24	Por la tarde a las tres, lo peina en su sala.	At three in the afternoon, she brushes his hair in the park.
25	Por la noche a las ocho, la pinta en su sala.	At eight at night, he paints her in their living room.
26	Por la noche a las ocho, lo regaña en el parque.	At eight at night, she scolds him in the park.
27	Por la noche a las ocho, la saluda en el parque.	At eight at night, he greets her in the park.
28	Por la mañana a las ocho, lo señala en su cocina.	At eight in the morning, she points at him in their kitchen.
29	Por la tarde a las tres la sigue en su cocina.	At three in the afternoon, she follows him in their kitchen.
30	Por la tarde a las tres, lo viste en su sala.	At three in the afternoon, she dresses him in the kitchen.

Note. These 30 sentences were the basis for an addition 150 unique sentences.

APPENDIX B

Instructions for the within-subjects baseline block

In this task you will complete a picture-sentence matching activity.
You will have to choose which picture best describes a sentence.

In order to complete the task you will do the following steps for each sentence:

1.Read a sentence
2. Press the spacebar to display two pictures
3. Decide which image best matches the sentence on the previous slide by pressing the corresponding LEFT and RIGHT button on the controller

Once you move on to the next step you cannot go back.

Let's try some practice items in English before beginning the task in Spanish.

Press the spacebar to continue.

APPENDIX C

Instructions for the experimental block in the external attentional condition

In this task you will complete another picture-sentence matching activity.
You will have to choose which picture best describes a sentence.

In order to complete the task you will do the following steps for each sentence:

1.Read a sentence
2. Press the spacebar to display two pictures
3. Decide which image best matches the sentence on the previous slide by pressing the corresponding LEFT and RIGHT button on the controller

Once you move on to the next step you cannot go back.

Let's try some practice items in English before beginning the task in Spanish.

Press the spacebar to continue.

APPENDIX D

Instructions for the experimental block in the internal attention condition

In this task, you will complete a picture-sentence matching activity.
You will have to choose which picture best describes a sentence.

In order to complete the task you will do the following steps for each sentence:

1.Look at two pictures
2. Press the spacebar to display a sentence
3.Read the sentence
4. Press the spacebar to display the pictures again
5. Decide which image best matches the sentence on the previous slide by pressing the corresponding LEFT and RIGHT button on the controller

Once you move on to the next step you cannot go back.

Let's try some practice items in English before beginning the task in Spanish.

Press the spacebar to continue.

APPENDIX E

Instructions for the experimental block in the control condition

In this task you will complete a picture-sentence matching activity.
You will have to choose which picture best describes a sentence.

In order to complete the task you will do the following steps for each sentence:

1.Read a sentence
2. Press the spacebar to display two pictures
3. Decide which image best matches the sentence on the previous slide by pressing the corresponding LEFT and RIGHT button on the controller

Once you move on to the next step you cannot go back.

Let's try some practice items in English before beginning the task in Spanish.

Press the spacebar to continue

APPENDIX F

Instructions for learning assessment task

In this task, you will complete a picture-sentence matching activity. You will select the picture that best represents the sentence on the screen by pressing the corresponding LEFT or RIGHT button on the top of the controller.

APPENDIX G

Language Background Questionnaire

Background Questionnaire

SECTION A: ***GENERAL INFORMATION***

1. Gender: Female _____ Male_____
2. Age: _____
3. Race: _____ American Indian or Alaskan Native
   _____ Asian or Pacific Islander
   _____ Black, not of Hispanic Origin
   _____ Hispanic
   _____ White, not of Hispanic Origin
   _____ Other _____
4. Highest level of education completed: _____ (e.g., BA., 3 yrs of college, etc.)

   Program of study/major: _____ (e.g., Economics)

SECTION B: ***LANGUAGE BACKGROUND***

1. Are you a native speaker of English? Yes _____ No _____
2. Please complete the following chart starting with your native language (the one you grew up speaking) and include any other languages you have learned. In the section '**Where you were exposed**', please be sure to circle all places that apply to your language experience.

Language	**Age first exposed**	**Where you were exposed**	**Please rate your proficiency based on the rate of 1 of 5. '1' indicates lowest proficiency. '5' indicates highest proficiency.**			**Comments**
			Reading	**Writing**	**Speaking**	
ex. English	**Birth**	**Home/ School / Other**	**1 2 3 4 5**	**1 2 3 4 5**	**1 2 3 4 5**	**I grew up in Chicago**
		Home/ School / Other	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
		Home/ School / Other	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
		Home/ School / Other	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
		Home/ School / Other	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	

SECTION C: ***MORE ABOUT SPANISH***

1. Have you taken any basic Spanish classes anywhere other than UIC: **YES** _____ **NO** _____

APPENDIX G (CONT.)

a. If YES, how many years have you studied Spanish before coming to UIC?

_____

2. How many **hours per week** do you spend using Spanish to do the following activities...

Do homework	0	1-2	3-4	5-6
Prepare for quizzes and exams	0	1-2	3-4	5-6
Listen to music	0	1-2	3-4	5-6
Talk to friends	0	1-2	3-4	5-6
Watch TV, videos & movies	0	1-2	3-4	5-6
Talk to family members	0	1-2	3-4	5-6

APPENDIX H

Vocabulary test

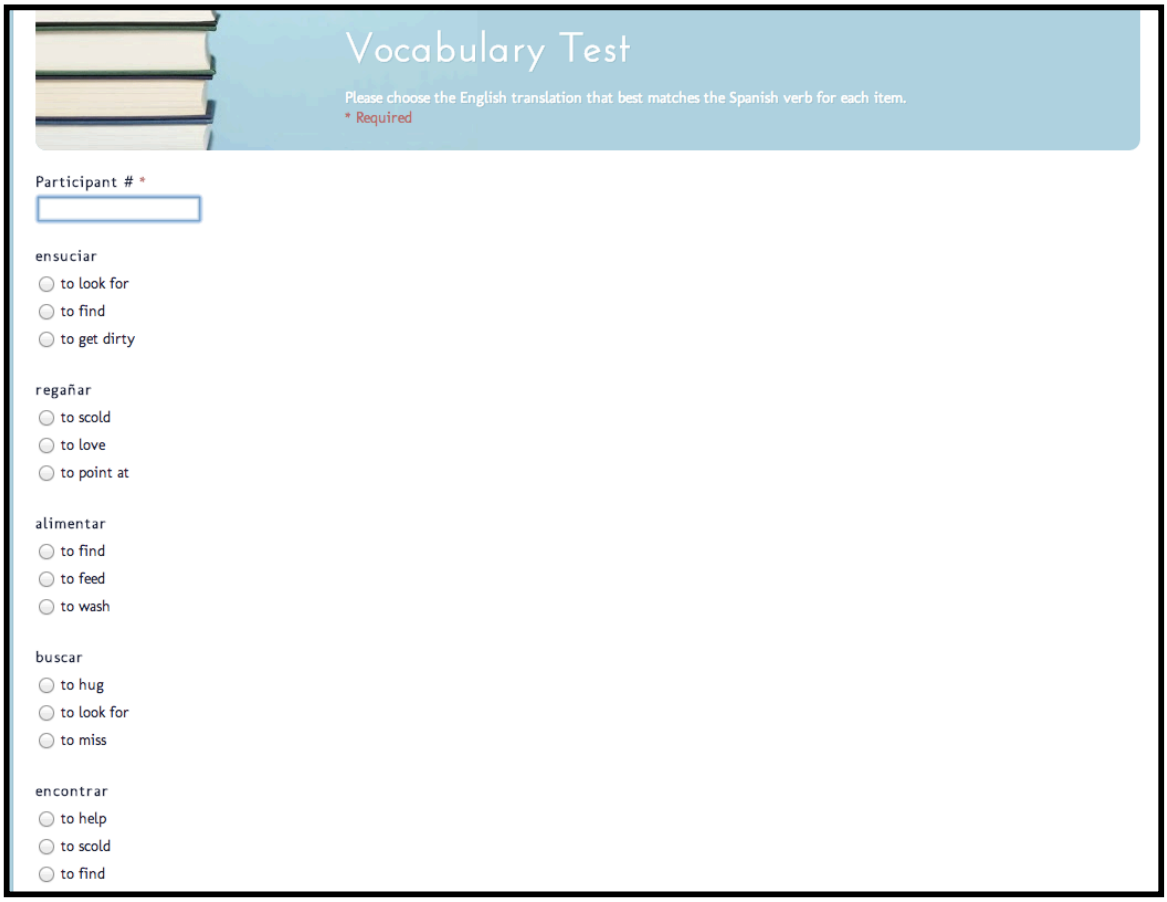
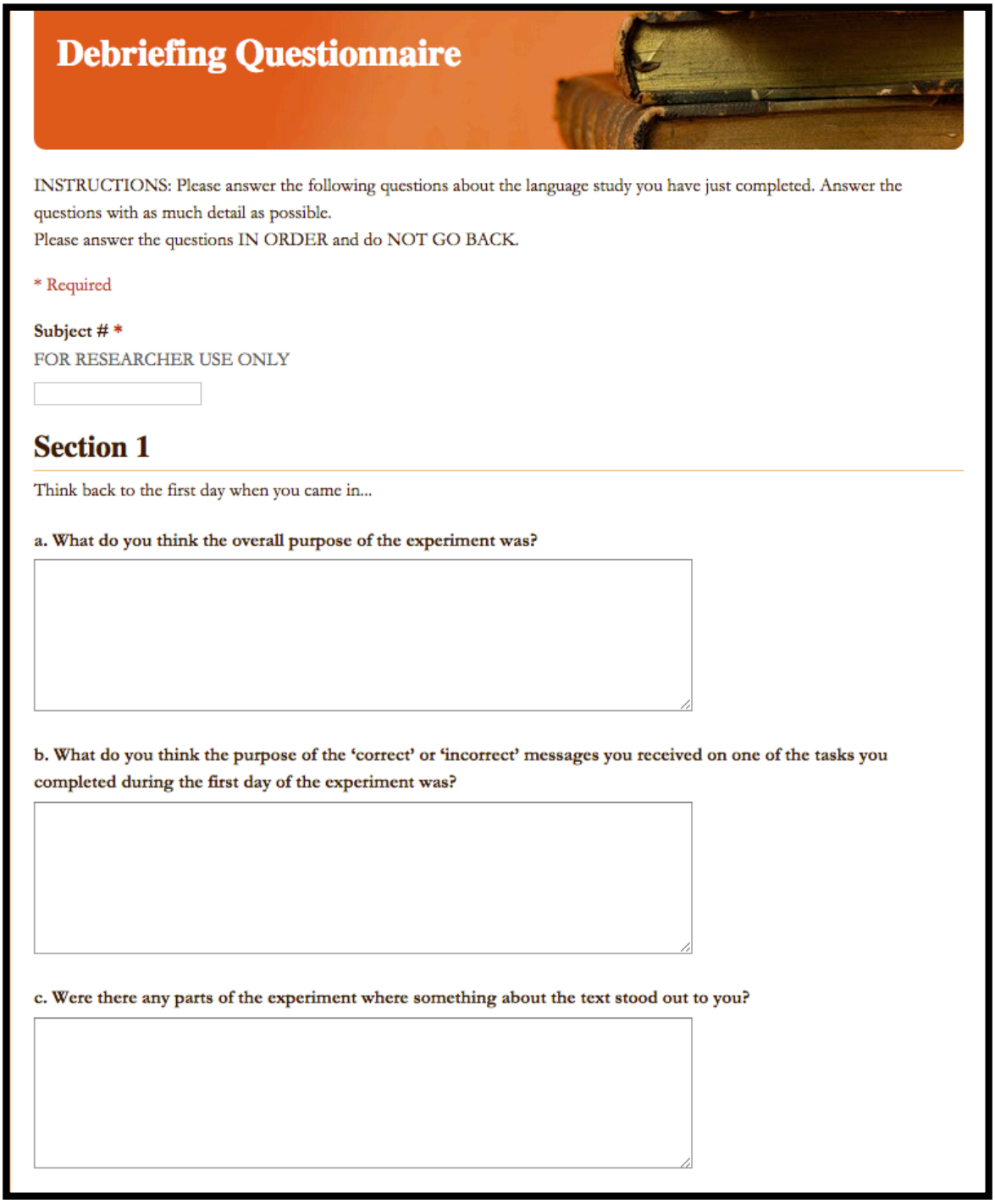


Figure 1H. Screenshot of vocabulary test used to ascertain participants' familiarity with the verbs used in the experiment. This test is administered through Google Drive and the full test can be accessed here: http://bit.ly/166eDWk

APPENDIX I

Debriefing Questionnaire



Debriefing Questionnaire

INSTRUCTIONS: Please answer the following questions about the language study you have just completed. Answer the questions with as much detail as possible.
Please answer the questions IN ORDER and do NOT GO BACK.

* Required

Subject # *

FOR RESEARCHER USE ONLY

Section 1

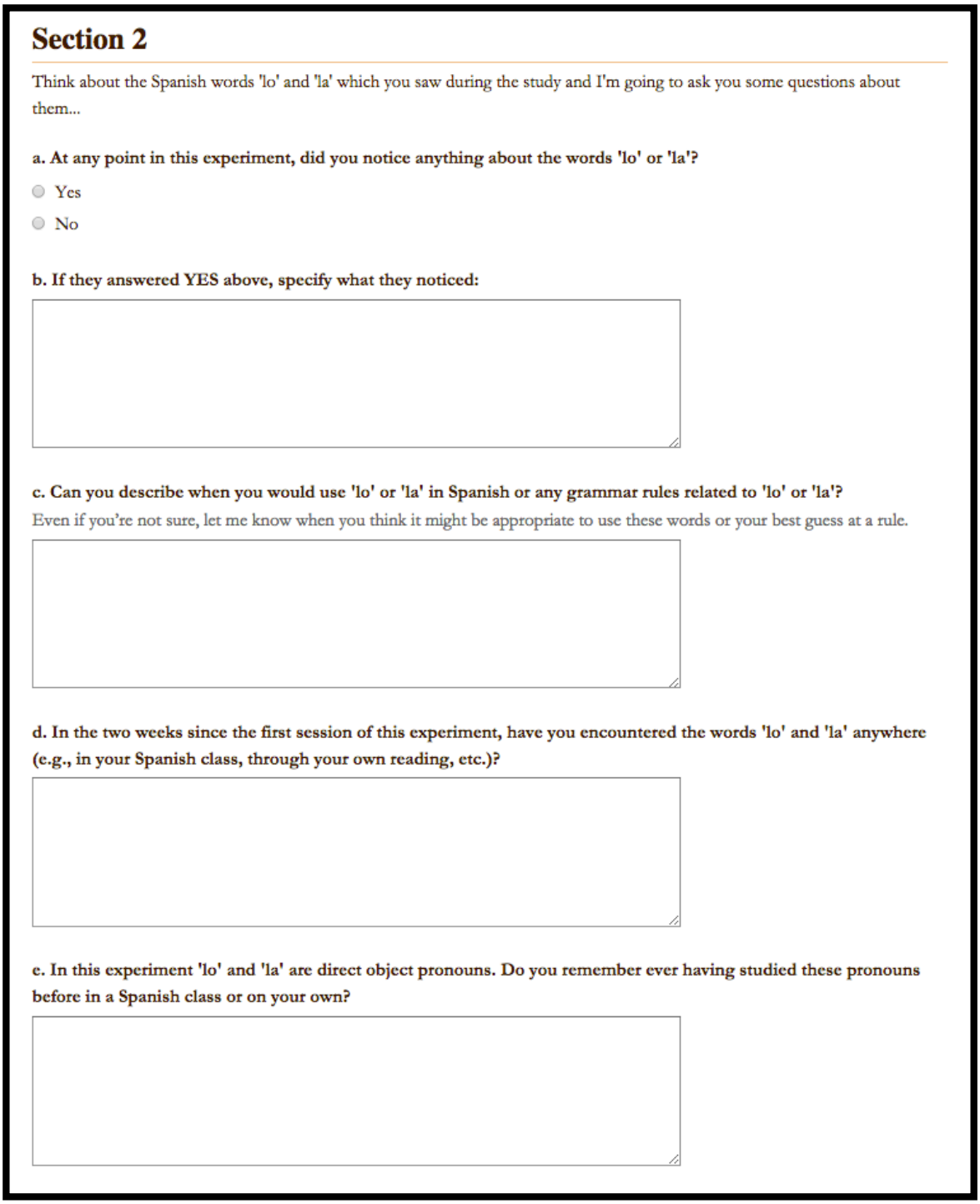
Think back to the first day when you came in...

a. What do you think the overall purpose of the experiment was?

b. What do you think the purpose of the 'correct' or 'incorrect' messages you received on one of the tasks you completed during the first day of the experiment was?

c. Were there any parts of the experiment where something about the text stood out to you?

APPENDIX I (CONT.)



Section 2

Think about the Spanish words 'lo' and 'la' which you saw during the study and I'm going to ask you some questions about them...

a. At any point in this experiment, did you notice anything about the words 'lo' or 'la'?

- Yes
- No

b. If they answered YES above, specify what they noticed:

c. Can you describe when you would use 'lo' or 'la' in Spanish or any grammar rules related to 'lo' or 'la'?

Even if you're not sure, let me know when you think it might be appropriate to use these words or your best guess at a rule.

d. In the two weeks since the first session of this experiment, have you encountered the words 'lo' and 'la' anywhere (e.g., in your Spanish class, through your own reading, etc.)?

e. In this experiment 'lo' and 'la' are direct object pronouns. Do you remember ever having studied these pronouns before in a Spanish class or on your own?

Figure 1I. Screenshot of Debriefing Interview questions used by the researcher to conduct the oral debriefing interview

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