UNIVERSITÉ DU QUÉBEC À MONTRÉAL

ATTENTION AND SECOND LANGUAGE SPEECH PRODUCTION: THE RELATIONSHIP BETWEEN ATTENTION AND THE PRODUCTION OF SELF-INITIATED SELF-REPAIRS

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ATTENTION ET PRODUCTION ORALE EN LANGUE SECONDE : LA RELATION ENTRE L'ATTENTION ET LA PRODUCTION D'AUTOREFORMULATIONS AUTOAMORCÉES

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À la douce mémoire de ma mère

Quand tu regarderas le ciel, la nuit, puisque j'habiterai dans l'une d'elles, puisque je rirai dans l'une d'elles, alors ce sera pour toi comme si riaient toutes les étoiles.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

RÉSUMÉ

L'attention joue un rôle critique dans la production orale en langue seconde (L2). En effet, de nombreux chercheurs (p. ex., de Bot, 1992; Kormos, 2006; Robinson, 2005) considèrent la production orale comme une tâche exigeant une capacité efficiente de commuter l'attention entre de multiples processus parallèles dont l'exécution varie selon les ressources cognitives qu'ils exigent. Comme les locuteurs varient en fonction de leur capacité de commuter efficacement leur attention, on pourrait s'attendre à ce que cette variation se reflète également dans certaines caractéristiques de leur production orale. Deux études (c.-à-d., Fincher, 2006; Simard, Fortier et Zuniga, 2011) se sont penchées sur cette question, en faisant des corrélations entre des données recueillies à l'aide d'un test psychométrique d'attention et la production d'autoreformulations autoamorcées, ces dernières étant vues comme une manifestation de l'allocation de l'attention. Les chercheurs n'ont pas trouvé de lien entre les autoreformulations et leur mesure d'attention. Simard et ses collaborateurs (2011) se sont servis d'une mesure capacitaire, mais ils affirment que l'emploi d'une mesure processuelle de l'attention lors de recherches futures pourrait donner des résultats plus fructueux.

Notre étude vise donc à déterminer si la capacité de commuter son attention est liée aux autoreformulations autoamorcées produites lors de la production orale en langue seconde. De plus, comme plusieurs études ont démontré que la compétence en L2 influence la production d'autoreformulations (p. ex., Kormos, 2000a, 2000b; O'Connor, 1988; van Hest, 1996; Verhoeven, 1989), et comme la production en langue maternelle (L1) et en L2 est gérée par les mêmes processus cognitifs sous-jacents (Segalowitz, 2010), un deuxième objectif a été établi afin de déterminer si la relation entre l'attention et la production d'autoreformulations est influencée par la compétence en L2 et le comportement lié à la production d'autoreformulations en L1. Nous avons donc formulé les questions de recherche suivantes : 1) Y a-t-il un lien entre la capacité de commuter l'attention et la production d'autoreformulations produites lors de la production orale en L2? Si oui, ce lien est-il influencé par le niveau de compétence en L2 et par la production d'autoreformulations en L1?

Afin de répondre à ces questions, nous avons mené une étude auprès de 58 locuteurs adultes du français L1 et de l'anglais L2 de niveaux de compétence variables. Les participants ont effectué les quatre tâches suivantes : un texte lacunaire, pour obtenir un indice de la compétence en L2; le *Trail Making Test*, pour obtenir une mesure de la capacité de commutation attentionnelle; la narration d'une histoire en L2 et en L1, pour observer des autoreformulations. Des analyses de régression nous ont permis d'affirmer que la capacité de commuter son attention contribue de façon significative au comportement d'autoreformulation en L2. Quant au rôle de la compétence en L2, sa contribution s'est révélée mineure. Pourtant, le comportement d'autoreformulation en L1 est apparu comme étant le facteur le plus important de la production d'autoreformulations en L2. Des analyses supplémentaires ont montré que la capacité de commutation de l'attention influence significativement la production d'autoreformulations autoamorcées en L1 autant qu'en L2, ce qui suggère qu'une partie de la contribution du comportement en L1 au comportement en L2 est effectivement l'attention. Ces résultats contribuent à dresser le portrait du rôle complexe que joue l'attention dans la production orale en L2.

Mots clés : production orale en langue seconde, production de la parole, autoreformulation, autoreformulation autoamorcée, attention

ABSTRACT

Attention plays a critical role in second language (L2) speech production. Accordingly, many researchers (e.g., de Bot, 1992, Kormos, 2006, Robinson, 2005) regard speaking as an attention-management task. Fluent L2 speaking indeed requires the efficient coordination of attentional resources to multiple parallel, on-line processes varying according to consumption demands. As speakers vary with regard to attentional capacity, it might be expected that speech production behavior would vary in accordance. Two previous studies (i.e., Fincher, 2006; Simard, Fortier, & Zuniga, 2011) have attempted to explore this link by correlating attention data gathered through psychometric tests and occurrences of self-initiated self-repairs, which are regarded as a manifestation of the allocation of attentional resources. These studies did not find a link between self-repair behavior and their measure of attention. Simard *et al.* (2011) used a measure of brut attentional capacity and argued that future research using a measure of a processual aspect of attention, which I refer to as *attention-management*, could yield more fruitful results.

The objective of the present study was therefore to determine whether attention-management capacity is linked to L2 self-repair behavior. Furthermore, since L2 proficiency has been shown to influence L2 self-repair behavior (e.g., Kormos, 2000a, 2000b; O'Connor, 1988; van Hest, 1996; Verhoeven, 1989), and since native language (L1) and L2 speech production are governed by the same underlying cognitive processes (Segalowitz, 2010), a second objective was established to determine whether the attention-L2 self-repair relationship is mediated by L2 proficiency and L1 self-repair behavior. I therefore formulated the following research questions: 1) Is there a relationship between attention management capacity and self-repair behavior in L2 speech production? 2) If there is a relationship between attention management capacity and self-repair behavior in L2 speech production, is that relationship mediated by L2 proficiency level and L1 self-repair behavior?

To answer these research questions, 58 university-level French L1 English L2 speakers of various proficiency levels were recruited to perform four tasks. The Trail Making Test was used to obtain a measure of attention-management capacity. This was followed by a cloze procedure, which offered an indication of proficiency level. Finally, L2 and L1 self-repair data were collected through a recorded picture-cued narration task. Linear regression analyses allowed me to determine that attention-management capacity does significantly contribute to L2 self-repair behavior. L2 proficiency was however revealed as an insignificant contributor while L1 self-repair behavior was shown to be the strongest predictor of L2 self-repair behavior. Supplemental analyses confirmed that attention-management capacity is a major contributor to both L1 and L2 self-repair behavior, suggesting that a large part of the L1 contribution to L2 repair behavior is likely attention-management itself. This study contributes to the development of a portrait of the complex role that attention plays in L2 speech production.

Key words: second language speech production, self-initiated self-repairs, attention

INTRODUCTION

Since the publication of Schmidt and Frota's (1986) seminal case study on the development of conversational ability, attention has captured the interest of many second language acquisition (SLA) researchers. The culmination of this research has resulted in widespread agreement among researchers (e.g., N. Ellis, 1994; R. Ellis, 1997, 2008; Gass, 1988, 1997; Robinson, 1995, 2001; Schmidt, 1990, 1993, 1995, 2001; Skehan, 1998; Swain, 1993, 1995; VanPatten, 1990, 1994, 1996) that attention is, if not necessary, a great enhancer of SLA. One of the primary objectives of attention research in SLA has been largely focused on understanding the role of attention in language acquisition (e.g., Bialystok, 1994; Carr & Curran, 1994; N. Ellis, 1994; R. Ellis, 1997, 2008; Gass, 1988, 1997; Robinson, 1995, 2001; Schmidt, 1990, 1993, 1995, 2001; Skehan, 1998; VanPatten, 1990, 1994, 1996). Another primary objective of research has been to develop an understanding of the role of attention in *second language (L2) speech production* (hereafter, speech production), which entails the automatic coordination of various production processes such as conceptual planning (e.g., the elaboration and organization of semantic propositions), morphophonological processing and articulation. Such speech production research can be divided into two broad categories: 1) *acquisition-based studies* examining the role of speech production in harnessing the attention necessary for SLA (e.g., Golonka, 2006; Griggs, 1997, 2003; Izumi 2003; Swain, 1985, 1995; Swain & Lapkin, 1995), and 2) *production-based studies* using self-repairs, with the understanding that they represent instances of attention allocation, to examine the linguistic aspects to which L2 speakers allocate attention during production (e.g., Arroyo, 2003; Camps, 2003; Fathman, 1980; Gilabert, 2007; Griggs, 1988, 2003, 2007; Kormos, 2000a, 2000b; Lennon, 1984; O'Connor, 1988; Tarone & Parrish, 1988; Verhoeven, 1989).

Based on principles stemming from notions such as Schmidt's (2001) noticing hypothesis, authors of acquisition-based studies (e.g., Golonka, 2006; Griggs, 1997, 2003; Izumi 2003; Swain, 1985, 1995; Swain & Lapkin, 1995) see speech production as crucial to the allocation of attention to gaps in second language (L2) speakers' present linguistic knowledge, thus facilitating acquisition. This perspective, which might be coined as the *output perspective*, conceives of a role for attention in acquisition that is quite different from that conceived of by studies targeting language comprehension, that is, studies from the *input perspective*. From such a comprehension-based position, attention is initially allocated to extracting meaning from the semantic content of incoming messages, and only after meaning extraction are remaining resources, barring their absence, allocated to the grammatical form of messages (VanPatten, 1996, p. 17). By contrast, as speakers produce language, they are forced to draw attention not only to the semantic but also the syntactic, morphological and phonological structure of the utterances they generate (Swain & Lapkin, 1995, p. 372). It is argued that such allocation of attentional resources to gaps in learners' linguistic knowledge promotes SLA.

Diverging from acquisition-based inquiries, *production-based studies* have been oriented toward understanding how attention is allocated to the various semantic and morphophonological features involved in speech production (e.g., Arroyo, 2003; Bange & Kern, 1996; Camps, 2003; Fathman, 1980; Fincher, 2006; Gilabert, 2007; Griggs, 1997, 1998, 2007; Kormos, 1998, 1999a, 1999b, 2000a, 2000b; Lennon, 1984; O'Connor, 1988; Simard, Fortier, & Zuniga, 2011; Tarone & Parrish, 1988; van Hest, 1996; Verhoeven, 1989). What all these studies have in common with regard to attention is that they all depict speech production as an activity requiring the allocation of limited attentional resources across multiple parallel processes. Indeed, widely cited L2 speech production models (e.g., de Bot, 1992; de Bot & Schreuder, 1993; Dörnyei & Kormos, 1998; Kormos, 2006) depict production as an attention management activity, wherein speakers must coordinate the allocation of limited attentional resources between multiple parallel processes.

Most of these speech production models (e.g., de Bot, 1992; de Bot & Schreuder, 1993; Dörnyei & Kormos, 1998; Kormos, 2006) depict the role of attention allocation. Each of their respective representations illustrates production as occurring in four consecutive but parallel stages: The first stage consists of message conceptualization wherein speakers decide what they want to say and how they want to say it. During this stage, speakers select the intended speech act (e.g., give or solicit information), the elements they intend to include in the emerging message and how those elements will be spatially and temporally represented. The results of this stage of processing, that is, the semantic representation of the emerging message cast into propositional form, is then passed on to a message formulation stage where grammatical encoding takes place and then ultimately to an articulation stage where the articulatory score is realized as overt speech. Finally, each of these models includes a monitoring component that verifies the results of each stage of processing against speakers intentions and executes repairs upon detection of incongruities.

While attention is required for the proper functioning of each stage of production (de Bot, 1996; Kormos, 2006), its allocation varies according to levels of automaticity (de Bot, 1996). Indeed, automatic processes make fewer demands on attentional resources than controlled processes (Bialystok, 1994; DeKeyser, 1997). As conceptualization never fully automatizes, it remains a high consumer of attentional resources for both L1 and L2 speakers alike (de Bot, 1992). It is, in other words, not the greatest source of variation. Message formulation and articulation, on the contrary, vary from highly automatic for L1 and high-proficiency L2 speakers to highly controlled for low-proficiency L2 speakers (Segalowitz, 2000, 2010). Accordingly, lower-proficiency L2 speakers find themselves in a condition where a greater quantity of seemingly limited resources must be allocated to even more demanding processes.

Production-based studies can be further divided into two categories that I refer to as language-centered and speaker-centered studies. The main objective of *language-centered studies* (e.g., Bange & Kern, 1996; Fathman, 1980; Griggs, 1998; Gilabert, 2007; Lennon, 1984; Tarone & Parrish, 1988; van Hest, 1996) is to examine how attention interacts with variables external to the speaker, such as language or task, without regard for the role of the individual.

Various themes have emerged out of language-centered self-repair research. Namely, L2 speakers do not pay equal attention to all stages of the production process (i.e., conceptualization, formulation, and articulation) (e.g., Fathman, 1980; Lennon, 1984). Indeed, they tend to produce significantly more lexical repairs than grammatical encoding repairs (Fathman, 1980; Lennon, 1984). Such findings suggest that meaning-based errors are more salient to L2 speakers than form-based errors. A second theme emerging from language-centered work concerns L1 and L2 speech production differences with regard to self-repair frequency and the linguistic aspects targeted for repair (e.g., semantic and morphosyntactic) (e.g., Bange & Kern, 1996; van Hest, 1996). L2 speakers appear to produce significantly more repairs than L1 speakers (Bange & Kern, 1996; van Hest, 1996). Furthermore, L2-speakers tend to make more lower-lever grammatical or lexical encoding repairs while native-speakers make more discourse-level conceptual repairs (van Hest, 1996). Such findings likely represent the error-prone, developing grammatical encoding processes typical of L2 learners (Bange & Kern, 1996). Finally, task complexity appears to have an influence on attention allocation and consequently on L2 self-repair behavior (e.g., Tarone & Parrish, 1988; Griggs, 1998, Gilabert, 2007). As tasks become more open-ended (e.g., role-plays and interviews) they generate more grammatical encoding repairs, and, therefore, appear to draw more attention to form than restricted tasks (e.g., grammaticality judgment tasks). Open-ended tasks requiring on-line processing generate more complex discourse (Skehan & Foster, 1997). Such discourse would tax unautomatized formulator processes therefore generating more errors and other disfluencies (Segalowitz, 2000, 2010), and thus more activity for the monitoring process. Taken together, these studies suggest that self-repair behavior is governed by underlying cognitive processes and that structural differences between speakers L1 and L2 linguistic systems, namely the unautomatized formulator processes of the L2, translate to differences in repair behavior patterns.

The aforementioned language-centered studies have resulted in a relatively coherent, but incomplete, understanding of the relationship between attention and language production. As a whole, they define language production as requiring the coordination of limited attentional resources across various parallel processes, themselves varying according to levels of automaticity related to L2 proficiency or task complexity. While the results of these studies seem to provide evidence of underlying traits that govern self-repair behavior, they all have looked at the relationship between speech production and attention as a general concept, omitting the perspective of attention as a cognitive trait that varies from individual to individual. A preliminary question emerging out of these explorations concerns, therefore, the role of the individual in the efficient allocation of these resources during L2 production. Nonetheless, as these language-centered studies are not concerned with variation among individuals, it is impossible to draw further conclusions.

To answer such questions concerning individual variation, one can turn to another domain of research, which I refer to as speaker-centered studies. In contrast with language-centered research, *speaker-centered studies* (Fincher, 2006; Kormos, 1999b, 2000a, 2000b; O'Connor, 1988; Simard *et al.*, 2011; van Hest, 1996, Verhoeven, 1989) examine the role of individuals, with respect to variation in individual cognitive traits (i.e., memory, attention, non-verbal intelligence) in speech production. Based on the assumption that speaking requires cognitive resources (de Bot, 1992; Kormos, 2006) and that these resources vary from one individual to another, speaker-centered research aims to establish a link between speech production and variation in the cognitive traits of individuals by exploring relationships between self-repair behavior and psychometric test results.

Studies in this field have exploited self-repairs, which are seen as an observation window into the cognitive processes of the speaker (Royer, 2002), to explore the role of variation in aspects such as non-verbal intelligence (e.g., Verhoeven, 1989), monitoring preferences (e.g., Kormos, 1999b), memory (e.g., Fincher, 2006) and attentional capacity (e.g., Fincher, 2006; Simard, Fortier, & Zuniga, 2011) in speech production. According to Kormos (2000a, 2006), the role that attention plays in self-repairs is a neglected field of study, especially in light of the importance that attention plays in SLA (Schmidt, 1990, 1992, 1994, 2001) and in the monitoring of discourse (Kormos, 1999a).

One of the earliest known studies to examine the role of attention in L2 speech production was conducted by Fincher (2006), who investigated the effects of variation in attentional and memory capacity on the self-repairs of five Japanese L2 learners during seven hours of recorded in-class interaction. Fincher did not find a link between her measures of memory and attention and self-repair behavior. Simard *et al.* (2011) later tried to answer this same question, arguing that the insignificance of Fincher's results might have been attributed to the small number of participants recruited for her study and the validity of her measurement instruments: Fincher used a test measuring only participants' perception of their attentional capacity. The researchers collected self-repair data through an elicited narration protocol and measured attentional capacity using a psychometric test designed to measure test-taker's ability to maintain concentration across time. Similar to Fincher (2006), Simard *et al.* (2011) did not find a correlation between their measure of attentional capacity and self-repair behavior. The authors argued, however, that a measure of attention-shifting capacity (i.e., an individual's ability to allocate attention to multiple parallel speech production processes efficiently), rather than ability to sustain concentration, would likely offer a clearer picture of the role of attention in L2 speech production. The authors explain that, during oral production, L2 speakers must shift their attention from one language feature to another. They argue that L2 learners' attention shifting-capacity facilitates encoding and self-monitoring. This reasoning is in line with claims that language production is an attention-management task in which speakers must coordinate the allocation of attentional resources between multiple parallel processes while speaking (e.g., de Bot, 1992; Kormos, 1999a; Robinson, 2005). The general objective of the present study was formulated in response to these findings.

The present study fits into the speaker-centered paradigm insofar as our aim is to verify whether a link exists between speakers' attention-management capacity as an individual trait and the allocation of attention during L2 speech production through the observation of self-repair behavior. However, as L2 and L1 speech production processes are governed by the same underlying cognitive traits (Segalowitz, 2010), and as those traits appear to be mediated by L2 proficiency in L2 speech production, an investigation of L2 self-repair behavior without consideration of L2 proficiency and L1 self-repair behavior would result in an incomplete portrait. A secondary objective was therefore established to examine the possible contributions of L2 proficiency and L1 self-repair behavior on L2 self-repair behavior.

CHAPTER I

ATTENTION AND SPEECH PRODUCTION

1.1 Introduction

In order to illustrate the conceptualization of attention used in the present study, I will first define both the characteristics and the functions of attention (1.2). Following a review of the most common speech production models in the field (1.3), I will situate attention into a speech production model (1.4), which will allow me to elaborate an appropriate model of attention for L2 speech production (1.5). I will then conclude the first part of this chapter with a synthesis of attention and L2 speech production (1.6). In the second part of this chapter, I will first show how the observation of self-repairs can serve as an observation window into attention management and the allocation of attentional resources during production (1.7), followed by a review of the L2 self-repair literature (1.8). I will conclude with a presentation of the research questions and a justification of the resulting hypothesis (1.9).

1.2 Attention

"Everybody knows what attention is." This well-known quote from William James (1890, p. 261) illustrates how the notion of attention has been a part of everyday parlance since at least the late nineteenth century. In these early hours of modern psychology, William James (1890, p. 261) depicted attention as the point of entry into consciousness for stimuli originating from both the internal musings of the mind (*passive intellectual attention*) as well as the external world (*passive immediate sensorial attention*). His formal definition of attention expresses three notions that would dominate research over the next century: James defined attention as "the taking of possession by the mind, in clear and vivid form, of one out of what seems several simultaneously possible objects or trains of thought. Focalization, concentration, and consciousness are of its essence" (p. 261). This part of his definition illustrates the notion of *selectivity*. Humans cannot pay attention to all things at once. James further asserted that attention "implies withdrawal from some things in order to deal effectively with others" (p. 261). This claim frames attention as *a limited capacity resource* by intimating that a lack of infinite resources makes it necessary to withdrawal from unselected stimuli in order to effectively process selected input. These ideas have been at the heart of the debate in the volumes of attention research that has been produced in the field of cognitive psychology since the publication of Broadbent's (1958) seminal book, *Perception and communication*, which one might consider the birth of modern attention research. In this section, I will first demonstrate how these notions have influenced the dominant conceptions of the characteristics of attention in the field of cognitive psychology by presenting various limited-resource models (1.2.1). In the second part of this section, I will present neuropsychological research defining the functions of attention (i.e., detection, orientation, alertness) (1.2.2), and illustrate how this work incited a paradigm shift in how the apparent limited nature of attention was conceptualized. I will conclude this section by presenting a model of attention based on selection-for-action (1.2.3), according to which the role of attention is to coordinate the allocation of cognitive resources rather than protect limited-capacity cognitive processes from information overload.

1.2.1 Characteristics of attention

The debate over the characteristics of attention has been the result of an effort to explain the seemingly limited nature of attention. From this debate, three general models of attention have emerged and evolved over the past five decades: *selective attention models* that support representations of attention as a limited resource that can not be distributed in a graded manner across multiple competing demands (1.2.1.1), *limited-capacity single-resource* (1.2.1.2) *and multiple-resource models* (1.2.1.3) that depict attention as being shared in graded degrees across multiple tasks.

1.2.1.1 Selective attention models

Early research on attention, both in the field of cognitive psychology and SLA, was dominated by *Filter Theory*, according to which attention acts as a limited capacity filter through which multiple stimuli compete for selection and entry into consciousness and memory (Broadbent, 1958; Moray, 1959; Treisman, 1960). For Broadbent (1958), the limiting nature of the filter played a crucial role in protecting a limited-capacity working memory[1] from overheating. The notion of selectivity, which was so central to Filter Theory, raised questions concerning the stage of processing at which the selection of stimuli takes place. From this debate, two camps emerged: *early* and *late selection theories.*

Broadbent (1958) was among scholars (e.g., Johnston & Dark, 1985; Treisman & Geffen, 1967; Treisman & Gelade, 1980; Ullman, 1984) who supported *early*

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[1] Broadbent (1958) conceived of the working memory as a gateway to the long-term memory. It is in the working memory where incoming stimuli are either rehearsed or attended to before entry into the long-term memory.

selection theories. Researchers from this position posited that only the simple physical attributes (i.e., shape, location, sound) of all incoming stimuli are identified by a sensory register from which the attention filter selects stimuli for further processing in the working memory. This implies that only selected stimuli ever enter into consciousness awareness.

Broadbent's work did not, however, go without criticism. In response to research providing evidence that more than just selected input is identified before selection (e.g., Moray, 1959; Treisman, 1960, 1964), Deutsch and Deutsch (1963) challenged Broadbent's filter theory with a *late-selection* alternative. Researchers adopting this position (e.g., Allport, 1987; Deutsch & Deutsch, 1963; Duncan, 1980; Marcel, 1983; Posner 1978, 1982; Schneider & Shiffrin, 1977) believe that all input stimuli must be fully identified, that is, not only for superficial physical attributes but also for meaning, before they can pass through a limited-capacity attentional system. To account for this processing, Deutsch and Deutsch (1963) envisioned a pre-attentional discriminatory and perception mechanism capable of reading both the physical attributes and the meaning of incoming stimuli. Attention is therein engaged when a given stimulus is activated to an established critical level, which allows for selection and further processing. From this standpoint, the initial phase of perception is accordingly unlimited while the subsequent cognitive processing is restricted. While the debate between early and late selection theories is not closed, "it is usually agreed that unattended information is not completely excluded even from complex semantic processing habitual to that stimulus" (Posner, 1982, p. 170).

1.2.1.2 Limited-capacity single-resource models

Attention research saw a paradigm shift in the 1970s during which Kahneman (1973) began challenging Filter Theory arguing that early-selection theories were too rigid and that late-selection theories were too loose to explain what often seemed like contradictory evidence supporting both positions (e.g., Moray, 1959; Treisman, 1960).

He proposed a more flexible and fluid model illustrating attention as a limited capacity resource that could be split between two simultaneous tasks as long as the demands of those tasks did not exceed resource capacity limits. Naturally, the notion of effort became a central feature of these models. On the one hand, *effort* is defined as a function of task demands, which refers to the quantity and quality of attention they require and to the degree to which the involved cognitive processes are automatized, that is, occur without demand for attentional resources. On the other hand, effort is also defined as a function of *arousal level*, that is, the degree to which individuals are invested in a given task. Such investment implies a role for goals and motivation. The allocation of attention therefore hinges on modulating variables both internal and external to the task doer.

Kahneman (1973) likened attention to a generator, wherein the capacity of the generator represents attentional capacity (p. 14). When only one appliance is plugged into the generator, its electrical demands are met, allowing the appliance to function normally. The addition of more appliances, depending on their electrical demand requirements, will tax the generator, perhaps diminishing the quantity of electricity available for the first appliance. One can imagine a light dimming upon starting a toaster oven. If, however, the sum of the appliances exceeds the generator's capacity, they will cease to function properly (Kahneman, 1973, p. 15). Accordingly, "when attention does not meet the demands [of a given task], performance falters, or fails entirely" (Kahneman, 1973, p. 9). While the Kahneman model accounts for dual task performance better than Filter Theory, it still does not explain why some task pairs (e.g., listening to a text and listening to music simultaneously) are inherently easier to perform than other task pairs (e.g., listening to two texts simultaneously). Multiple-resource models offer such an explanation.

1.2.1.3 Limited-capacity multiple-resources models

Based on findings that show that it is easier to perform two tasks simultaneously when those tasks are dissimilar (e.g., Duncan, 1980), Wickens (1980, 1984, 2007) extended Kahneman's model through the development of his multiple-resource model, and subsequently applied his model to SLA (Wickens, 2007). Wickens (2007) defined three elements that influence decrement in dual-task performance, two of which extend from Kahneman's model: task demands and the role of the individual in the allocation of attentional resources. The major contribution of the Wickens models is the addition of a third element, which he refers to as *qualitative resource similarity*, stating that the degree of similarity between two tasks modulates the degree to which the tasks draw on the same resource pools. If the two tasks draw on the same resource pool, task decrement will behave in the manner describe by Kahneman. However, if the tasks draw on different pools, there will be little or no decrement unless one of the tasks exhausts the resources of the pool on which it draws. Here is a common example: a person can walk and talk with little or no interference between the tasks (Wickens, 1984, p. 63). His or her success is due to the highly automatized processes characterizing the tasks, which require few resources. They also draw on separate resource pools according to Wickens' model. However, if the person is asked to perform a complex math operation during this walk, he or she is likely to stop walking in order to divert resources to this operation (Kahneman, 1973, p. 179).

Wickens defines these resource pools along three dimensions, which can be represented by a cube. Figure 1.1 offers a visual representation based on the Wickens model.

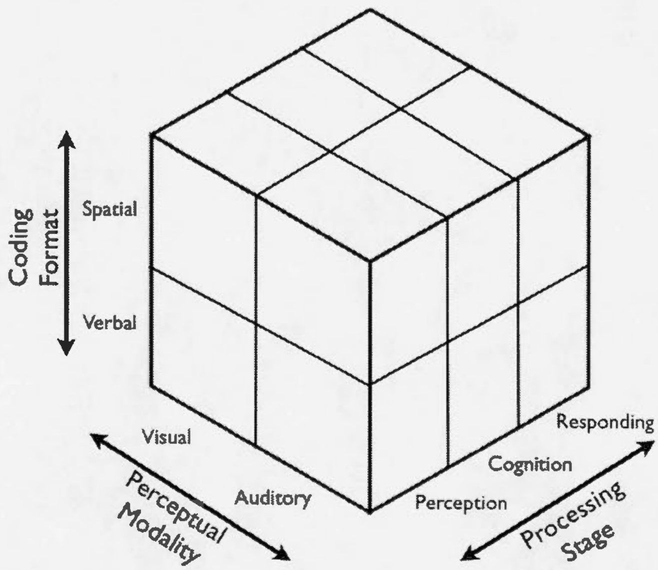

Figure 1.1. Visual representation based on the Wickens' model of attention[2]

The first dimension involves *perceptual modalities,* which refer to the processing of visual or auditory information. Secondly, this data can also exist in the form of either spatial or verbal *codes.* An example of processing audio/spatial data might be listening to or making music while processing audio/verbal data involves language comprehension and production. According to the Wickens' model, it is easier to listen to a text while listening to music than it is to listen to two simultaneously presented texts. Finally, the model accounts for three *processing stages*: perception, cognition, responding. With regard to language use, this final dimension allows for a distinction

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[2] Note. The figure is adapted form "Attention to the second language," by C.D. Wickens, 2007, *IRAL, 45*, p. 186.

between listening (auditory/verbal/perception) and speaking (auditory/verbal/-responding).

Both Kahneman's (1973) and Wickens' (1984, 2007) models are based on effort and capacity limits according to which performance decrement while carrying out two simultaneous tasks is a result of exhausting resources, even if those resources do not draw from the same resource pool. However, the concept of capacity limitations inherent in these models was challenged by advances in neuropsychological research on attention beginning in the 1990s, which provided evidence of multiple parallel distributed systems linked to attention. As a result, apparent limitations and subsequent task decrement would be attributed to interference and crosstalk between unlimited resource allocation to multiple parallel processes rather than to the bottleneck effect associated with Filter Theory. To illustrate this second paradigm shift, we turn to neuropsychological research on the functions of attention.

1.2.2 Functions of attention

I have thus far focused on questions concerning the characteristics of attention, that is, its limiting nature. Tomlin and Villa (1994) argue, however, that these notions offer only a coarse-grained analysis of attention. Based on what Posner and Peterson (1990) defined as the anatomy of attention, Tomlin and Villa (1994) offered what they refer to as a fine-grained analysis of the various functions of attention with specific regard to SLA. Drawing on neuroscience research (e.g., Posner, 1992; Posner, 1994; Posner & Peterson, 1990), they argue that attention is composed of three functions that occur in interconnected but anatomically separate parts of the brain: alertness, orientation and detection. "*Alertness* represents an overall, general readiness to deal with incoming stimuli or data" (Tomlin & Villa, 1994, p. 190); *orientation* refers to how "resources can be specifically directed to some type or class of sensory information at the exclusion of others" (Tomlin & Villa, 1994, p. 191); and *detection*[3] involves "the cognitive registration of sensory stimuli" (Tomlin & Villa, 1994, p. 192).

Tomlin and Villa's claims are based on studies using neuroimaging techniques (e.g., position emission tomography[4], event-related electrical or magnetic potentials[5]) (e.g., Fan, McCandliss, Sommer, Raz & Posner, 2002; Fan, McCandliss, Fossella, Flombaum & Posner, 2005; Posner, 1992, 1994, 1995; Posner & Peterson, 1990; Posner, DiGirolamo, & Fernandez-Duque, 1997) that have been used to explain how the various attentional functions occur in networks of anatomically separate areas of the brain. For example, the orientation network seems to involve the posterior parietal

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[3] More recent work on the functions of attention (e.g., Fan, McCandliss, Sommer, Raz, & Posner, 2002; Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; Posner & Raichle, 1994; Posner, Sheese, Odludas & Tang, 2006; Rueda, Posner, & Rothbart, 2005) uses the title of *executive attention network* to refer to detection. This network "involves mechanisms for resolving conflict among thoughts, feelings, and responses" (Rueda, Posner, & Rothbart, 2005, p. 576). It is therefore involved in error detection and repair execution and implies varying degrees of voluntary control over the allocation of attentional resources. With respect to speech production, it would involve the detection of mismatches between speakers' communicative intentions and the results of the actual message being produced, followed by the modification or repair of such mismatches.

[4] For positron emission tomography (PET), "a small amount of radio-activity is introduced into the body, which emits positions as the radio-active substance floats along with the blood. The positions are annihilated and give rise to gamma radiation, which can be measured by detectors outside the head. The locations from which the radiation can be used to calculate the blood flow in brain regions" (Posner, 1992, p. 12).

[5] Event-related potentials (ERP) are used in chronometric studies of attention. It consists of a recording of "electrical activity from the scalp time locked to stimulus events" (Posner, DiGirolamo, & Fernandez-Duque, 1997, p. 270). This allows researchers to identify the areas of the brain that are engaged with exposition to a given stimulus.

lobe, which allows individuals to disengage a current attentional fixation, the superior colliculus, which directs attention to the location of the new stimulus, and the pulvinar, which filters out non-essential information (Posner & Raichle, 1994). The executive attention network (i.e., detection) is then engaged after the orientation network completes its work, which is to bring objects into conscious awareness and to execute given instructions such as error detection or conflict resolution (Posner & Raichle, 1994). The anterior cingulate is the center of activity occurring in the executive network, which works as a relay station between other parts of the brain, in particular, those in the prefrontal cortex related to the working memory. Finally, the alertness network involves the right frontal and parietal lobes and sections of the mid brain that produce the chemical norepinephrine, which brings about alertness (Posner & Raichle, 1994). Citing such findings regarding the autonomy of these three attentional networks, Tomlin and Villa (1994) make a bold claim about the nature of the functions of attention, arguing that they operate independently of one another. The researchers thus claim that while alertness and orientation facilitate detection they are not necessary for it to occur.

Simard and Wong (2001), however, respond to Tomlin and Villa's claim, arguing that Tomlin and Villa misinterpreted the neuroscience research about the anatomical separation of such functions of attention. While the attentional functions involve separable networks in different areas of the brain, they "operate in conjunction with other systems that perform cognitive operations" (Posner, 1992, p. 14). Secondly, Simard and Wong (2001) also argue that we cannot generalize results from neuroscience research, which is based mostly on visual stimuli detection tasks, to SLA. It is quite possible that second language processing involves entirely different areas of the brain. Finally, they claim that presently, it is impossible to independently operationalize the functions so as to prove claims that they do operate separately. In addition to their critique, Simard and Wong (2001) offer a reconceptualization of attention.

> Rather than viewing alertness, orientation, detection, and awareness as separate and discrete all-or-none entities, we posit that a model of attention that more accurately reflects the complex nature of SLA is one in which awareness and attentional functions are viewed as being present in graded amounts, and whose degree of activation is influenced by the interactions among task type, linguistic items, individual differences (such as processing capacity), and by any other concurrent cognitive activity competing for processing resources (Simard & Wong, 2001, p. 119).

Simard and Wong's (2001) claim appears to be supported by subsequent neuroimaging studies using the *Attention Network Test* (ANT) (e.g., Callejas, Lupianez, & Tudela, 2004; Fan *et al.*, 2002, 2005), which allows for the independent operationalization of the three attention networks using a single task. With a modified version of the ANT, Callejas, Lupianez, and Tudela (2004) found significant interaction between the attention networks. They found an inhibitory effect of alerting on executive attention, which, they argue, allows for quick reaction times without interference from the feelings and thoughts linked to the executive attention network. Indeed, elevated levels of the norepinephrine associated with alertness has been shown to reduce activity in the anterior cingulate, which serves as the central relay station for the executive network (Posner & Raichle, 1994). Conversely, alerting was shown to accelerate orienting, wherein the alerting network acts as a primer. Finally, the authors found that the orientation network enhanced executive attention by helping to guide the focusing of attention on the intended target. Results from other ANT studies (e.g., Fan *et al.*, 2002, 2005) show more tepid results with regard to interaction between the attention networks, merely suggesting "that there are some interactions between the networks [...] even though they use different anatomy and chemical modulators" (Fan *et al.*, 2002, p. 344).

These advances in neuropsychological research raised serious questions about the validity of claims concerning the nature of attention as a limited resource. Rather than serving as a filter to protect limited central processing from information overload, attention is reconceptualized as a network of functions that operate in parallel to coordinate complex human activity, whereby task decrement is a result of inefficient coordination. This is the context in which Allport (1998) presented a model based on selection-for-action.

1.2.3 Models based on selection-for-action

Allport (1998) rejects claims that attention is limited in the manner illustrated by Filter Theory and by the multiple-resource models presented in section 1.2.1. In a paper elaborating a conceptual framework for attention based on selection-for-action, Allport (1998) argues that humans are goal-directed beings, and the primary role for attention is to assign priority needed to coordinate simultaneous and ever-changing time-sensitive tasks, wherein one goal or task is often incompatible with concurrent goals and tasks. From such a perspective, efficient task execution requires the coordination of the subcomponents of attention without interference or crosstalk from competing tasks. I refer to this coordination as *attention management.* In this sense, "limitations in the performance of many concurrent task-combinations can be understood as limitation in the ability to segment and to keep separate different processing streams" (Allport, 1998, p. 650), rather than as brute capacity limitations as illustrated by Filter Theory.

In the following sections, I will situate attention into a speech production model in order to demonstrate how a model of attention based on selection-for-action best explains the role of attention in speech production.

1.3 Speech production models

To select a speech production model that best illustrates the role of attention in speaking, it is appropriate to consider how each model conceives of the monitoring process, which, through self-repairs, provides an observation window into attention management. There are three types of models that have dominated the SLA field over the last 30 years: editor theories of monitoring, activation spreading models, and perceptual loop theory, which is a component of Levelt's blueprint for the monolingual speaker (1989).

According to *editor theory models* (e.g., Baars, Motley, & Mackay, 1975; Laver, 1980; Motley, Camden, & Baars, 1982), speech production is monitored by an independent editor containing its own system of rules against which it checks post-phonological but pre-articulatory speech production. The editor essentially approves appropriate strings and vetoes those deemed "anomalous" (Motley *et al.*, 1982, p. 578). As, according to this theory, the editor requires a duplication of knowledge that is already present in the speech production system, it is thought to be rather uneconomical (Levelt, 1989, p. 468).

Activation spreading models (e.g., Berg, 1986; Dell, 1986; Dell & O'Seaghda, 1991; MacKay, 1987, 1992) offer a wholly different approach to monitoring. Instead of an independent editor, speech production monitoring is integrated into the same mechanism used for comprehension. This theory is based on a bottom-up spreading of activation which also allows for a backwards flow of activation from higher to lower levels of processing. This is the source of Levelt's (1989) biggest criticism: He claims that such processes would eliminate all production errors, which, he contends, he did not observe in his 1982 data (p. 463).

The third type of monitoring system is known as the *Perceptual Loop Theory* (PLT) (e.g., Levelt, 1983, 1989, 1999; Levelt, Roelofs, & Meyer, 1999). Levelt refers to the monitoring component of his model as the *self-perception system*. In the same manner that individuals monitor the speech of their interlocutors, the self-perception system monitors the output at each stage of pre-articulatory processing (i.e., message conceptualization and grammatical encoding) as well as articulation. Once a mismatch between the output of one of the components and the speaker's intentions is detected, production is halted and the message is rerouted back to the first stage of processing (conceptualization) for correction. The role of attention is important throughout the monitoring process as it must be deployed to each stage of production to detect mismatches between speakers' intentions and the production outcomes (Levelt, 1989). The verbalized results of this monitoring are *overt self-repairs*.

The PLT has not gone without criticism. Levelt's *Main Interruption Rule* states that production is immediately stopped upon detection of an error and the message is sent back to the first stage of processing to begin anew. This implies that there should be a lag between the message cut-off and the repair. Blackmer and Mitton (1991), however, observed among their participants many cases where the cut-off and the repair were coupled without a lag, which indicates repairs being initiated before production is interrupted. Despite the criticism, Black and Mitton suggest that, excluding the Main Interruption Rule, the PLT explains fluid speech in the presence of covert and overt self-repairs. This position is also shared by many L2 speech production researchers (e.g., Brédart, 1991; Kormos, 2006; Poulisse & Bongaerts, 1994; Segalowitz, 2010), one of whom (i.e., de Bot, 1992), in fact, summarizes the underlying reasons for the success of Levelt's model, known as the Blueprint of the Monolingual Speaker.

> There are several reasons for taking Levelt's model as a starting point. The model is based on several decades of psycholinguistic research and is based on a wealth of empirical data, obtained through experimental research and the observation of speech errors. The present model is a further development of earlier proposals by Garrett (1975), Dell (1986), and Kempen and Hoenkamp (1987). A major advantage of the model is that it is not restricted to parts of the production process: its strength lies in the integration of the different parts (de Bot, 1992, p. 2).

It is thus not surprising that Levelt's model has also been the basis for subsequent, influential L2 speech production models (e.g., de Bot, 1992; Dörnyei & Kormos, 1998; Kormos, 2006). The present study follows suit. In the following subsections, I will present the Blueprint for the Monolingual Speaker (1.3.1), followed by a discussion of de Bot's (1992) L2 adaptation of the model (1.3.2) so as to illustrate the role of attention in L2 speech production.

1.3.1 Blueprint of the Monolingual Speaker

According to the Levelt model (1989, 1999), speech production is the result of the coordination between various levels of parallel but unidirectional processing taking place within two modular components: the conceptualizer and the formulator (see Figure 1.2). The *conceptualizer* is responsible for the generation of preverbal messages, which are delivered to the formulator in the form of rough semantic structures. The *formulator* executes the morphosyntactic and phonological encoding and generates the articulatory score. Each of these components requires procedural knowledge to varying degrees for optimal operation, but only the conceptualizer is heavily dependent on the processing of declarative knowledge extracted from both the working and long-term memories, and thus, unlike the formulator, never really operates free of attentional resources (de Bot, 1992; Levelt, 1989). Let us consider the role of attention at each level of processing.

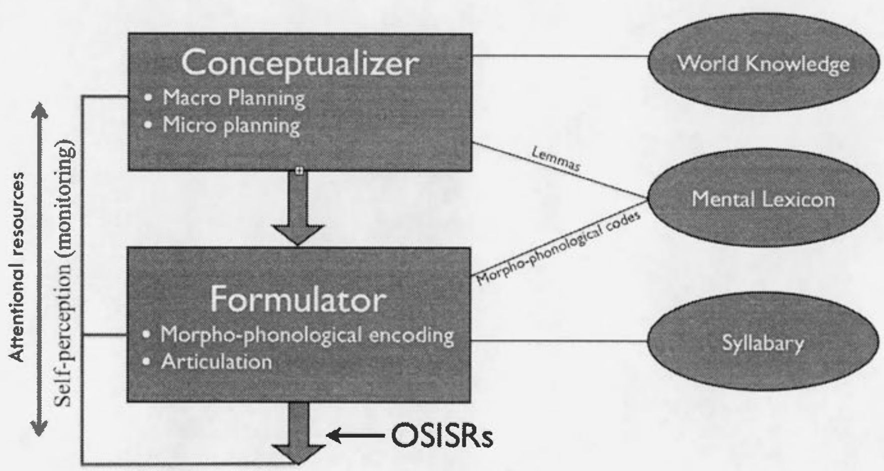

Figure 1.2. Illustration based on Levelt's 1999 speech production model

1.3.1.1 Attention and the conceptualizer

The production of any utterance finds its genesis in the conceptualizer. This is the stage where speakers' ideas and intentions are transformed into *preverbal messages*, that is, the "conceptual structures that can be accepted as input by the Formulator" (Levelt, 1989, p. 10). Conceptualization is broken down into two phases: a *macro-planning* phase where, based on intentions or goals, speakers determine which concepts to include in the emerging utterance and how to spatially and temporally represent them; and a *micro-planning* phase where the input from macro-planning is cast into propositional form.

1.3.1.1.1 Macro-planning

Conceptualization starts with macro-planning. This is the phase where speakers select a speech act as well as what they intend to include in the message and how to spatially and temporally represent it. Levelt (1999, p. 91) illustrates how speakers direct attention during this stage through reference to three principles: connectivity, stack, and simplest first. The *connectivity* principle states that speakers, in an effort to guide the attention of their interlocutors, will direct attention to an item that is directly linked to the currently focused item. The *stack* principle predicts that in the absence of another connecting item speakers will return to the previously mentioned item if there are no other items linked. The *simplest first* principle claims that speakers direct attention to the simpler item before complex items. De Bot (1992) argues that such macro-planning processes are not language specific and can never become automatized. They thus always demand attentional resources. As strings of output from the macro-planning phase are complete they are passed on for micro-planning.

1.3.1.1.2 Micro-planning

During the *micro-planning phase* the pre-verbal message is cast into propositional form, that is, "a semantic representation that refers to some state of affairs" before being handed off to the formulator (Levelt, 1989, p. 73). During this phase, speakers must keep track of the type of discourse in which they are involved, the current topic of discourse as well as antecedent concepts or referents. Accordingly, speakers form a *discourse model*, which is "the speaker's record of what he believes to be shared knowledge about the content of the discourse as it evolved" (Levelt, 1989, p. 114). This discourse model influences what Levelt describes as the four micro-planning stages of production: (1) In the *accessibility stage*, speakers must pay attention to the addressees' focus so as to determine how to package the information within the message. The speaker must determine if the information being transmitted is either inaccessible or accessible to the addressee, or if the information is in the addressees current discourse model or the current focus of the addressee. Each of these situations will impact the formation of the message differently. For example, if the speaker judges the information as inaccessible to the interlocutor, he will likely signal that information with an indefinite article. If, on the other hand, the information is judged as being currently in focus, the speaker will refer to it by anaphoric means. (2) The *topicalization phase* occurs as elements of the message are cast into propositional form: Old information is generally assigned the deaccentuated topic position of the proposition and new information will be accentuated by assignment to the predicate position. (3) During the *proposition phase*, the speaker must assign spatial perspective to the message in relation to how he wants the interlocutor to interpret it. (4) Finally, the speaker must consider language-specific aspects such as verb tense and aspect[6]. Among these four stages, the first three require speakers to attend to the emerging interactional situation so as to create a preverbal message that corresponds to their own intentions as well as the demands from the situation. Only the proposition phase, according to Levelt, becomes automatized, thus using fewer attentional resources.

As mentioned above, the conceptualizer is procedural in nature (Levelt, 1989, p. 124) in that speakers select from a limited number of speech acts (e.g., informing or inquiring) that correspond to their intentions. However, Levelt recognizes that the speaker is a dynamic interlocutor in interaction with the present communicative situation as well as past experiences stored in the long-term memory. This implies interplay between knowledge about the present communicative situation held in the working memory, and procedural and declarative knowledge of discourse models and encyclopedic knowledge held in the long-term memory. It is important to note that,

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[6] In a break from the strict modular nature of this model, in the 1999 version of the model, Levelt moved lexical access from a position located exclusively in the formulator to a position shared between the micro-planning phase of the conceptualizer and the formulator. According to this modification, the conceptualizer can access lemma information, that is, semantic information concerning, for example, word class or the argument structure of verbs. The formulator in turn accesses information about the morphological and phonological form of the lexical item. Such a modification makes sense in that micro-planning, particularly the proposition-casting phase, would require the syntactic and argument pointers that are tagged on each lemma to guide the roughing out of the semantic structure of the preverbal message. For example, the lemma for the verb *put* when used to denote an event function will include tags indicating the word class as a verb requiring three arguments: a PERSON, a THING and a PLACE [John] [put] [the book] [on the shelf]. Such indications are essential for the roughing out of the proposition form. However, Level's modification raises some problems in that the automatized nature of lemma access during the final stage of conceptualization seems more akin to the processes of the formulator.

with the exception of certain discourse models that have become proceduralized, this stage of production is mostly characterized by controlled processing and thus always places some demand on attentional resources. Whether one is a native speaker or a low-proficiency L2 speaker, one still needs to pay attention to what one wants to say and how one wants to say it. We can characterize the conceptualizer as a great consumer of attentional resources.

1.3.1.2 Attention and the formulator

The output of the conceptualizer becomes the input for the formulator. The formulator does not, however, need to wait for entire sentences to be completed before it can start processing. Levelt calls for a buffer between all the components of the model that receive and hold fragments of the output from the previous component as they become available. In this sense, the formulator can begin processing fragments as they arrive, generally in a left-to-right manner where the first fragment is assigned the role of subject, and so on. This buffer is seen as an essential element needed to account for fluent speech, for its absence would result in choppy production, which is certainly not characteristic of human speech.

It is here in the formulator where *grammatical encoding* takes place, that is, “the process by which a message is mapped onto a surface structure” (Levelt, 1989, p. 235). Levelt refers to this process as “unification.” It is lexically driven and incremental in nature, that is, it is the information contained in the lemma that organizes the environment of words into constituents such as noun, verb, adverbial and prepositional phrases. After grammatical encoding, strings of the message are passed on for phonological encoding and articulation. We will now look at these processes in more detail with regard to attentional resources.

1.3.1.2.1 Morphosyntactic encoding

In Levelt's 1989 model, morphosyntactic encoding was composed of six stages. However, as of the 1999 version, the first two stages take place in the conceptualizer, that is, (1) lemma retrieval through a process of activation-spreading and (2) syntactic category activation. Morphosyntactic processing now starts with (3) an inspection of the nature of the preverbal message, which permits (4) the assignment of determiners, case, and inflection. The elements are then (5) assembled into constituents. Finally, (6) the grammatical category of the constituents is assigned and they fall into place within the syntactic buffer among the other constituents in a left-to-right order. In L1 speakers, morphosyntactic encoding is fully automatic requiring little or no attentional resources (Levelt, 1989). For L2 speakers, this process varies from controlled to automatic processing, depending on proficiency level (Segalowitz, 2000, 2010). The 'unified' preverbal message is then passed on to the phonological/phonetic system for pre-articulatory morphophonological and phonetic encoding before execution of the articulatory score.

1.3.1.2.2 Phonological encoding

The observation of certain types of errors has allowed Levelt (1989) to propose a frame-slot-filler approach to explaining phonological encoding where lemmas activate empty frames with slots that are filled with morphemic and phonemic content until they are complete. In the first stage of this process, the morphological and metric composition (i.e., prosody) of a word is encoded. This information is passed on for segmental and syllabic spell out, and finally, phonetic spell out, where the plan for the articulatory gestures of the articulator are elaborated. Speakers are more or less aware of the phonetic plan through what Levelt refers to as *internal speech*. This is the stage where pre-articulatory monitoring of the formulator takes place. Errors detected here will result in pauses, hesitations and false starts, etc. However, while native speakers are aware of the phonetic plan, they are largely unaware of the extremely complex encoding processes that are part of its elaboration (Levelt, 1989). Again, while these processes are automatic for native speakers, they vary from controlled to automatic for L2 speakers. Let us now move on to the last stage of speech production, message articulation.

1.3.1.2.3 Articulation

The articulator receives the phonetic plan, that is, the output of the grammatical encoding that was produced in the formulator. According to Levelt, these data are delivered to the articulation buffer in units of phonological words and phrases. Each of these units contains the motor commands that the articulator needs to translate the mental representation of the sounds into real sound. Once retrieved from the buffer, the articulator "unpacks" and executes the motor commands that are used to coordinate articulation. This is likely one of the most intensely complex processes in which humans engage, in that "it involves the coordinated use of approximately 100 muscles [spread across the respiratory system and the laryngeal and super laryngeal systems], such that speech sounds are produced at a rate of about 15 per second" (p. 413). In terms of explaining the translation from the phonetic plan to the motor control needed for articulation, one thing is clear in the Levelt model: There is a wide range of theories and little convergence among them. An exhaustive review of these theories goes beyond the scope of this present study. It suffices to state, however, that, compared to all other speech production operations, the complexity of these operations would require the highest levels of proceduralization. In fact, in normal speech, these processes are so automatized and independent of executive control that Levelt likens them to the same processes that allow chickens to continue running even after their heads have been chopped off.

Considering the highly complex nature of articulation and the speed with which it is executed, it is not surprising that acquiring native-like mastery of pronunciation is the most difficult aspect of SLA (Matter, 2006). Indeed, Matter (2006) argues that as we move down the hierarchy of processing (e.g., from syntactic to phonological) more automatization is required, which, he argues, is why there are L2 speakers that appear to master morphosyntactic processing with the grace of a native speaker, but never seem to be able to loose their accent. De Bot (1992) uses this argument to claim that there is only one articulator for both the L1 and the L2. Such an argument also supposes that significant L1 to L2 transfer is inevitable, and that articulatory behavior in the L2 is very difficult to modify.

This description of the formulator processes illustrates how, for native speakers, most of what takes place here can be characterized by what Levelt calls "underground processes." The formulator is thus not a big consumer of attentional resources, which puts it in stark contrast with the conceptualizer. For learners of an L2, however, these processes progress from an initial state characterized as error-prone, highly controlled and demanding of attentional resources toward the development of automatized processes largely free of attentional constraint (DeKeyser, 2007; Segalowitz, 2010). We might say that a highly attention-demanding formulator is a rather unnatural but temporary state through which L2 learners pass.

1.3.1.3 Attention and the monitor

According to the Blueprint, monitoring takes place at all levels of processing. Although the monitor is situated in the conceptualizer, it also receives repair information from the formulator through what Levelt refers to as a *self-perception system* (Levelt, 1999). The self-perception system is essentially the same mechanism that is used to monitor others' speech. The emerging utterance is verified at three points in the production process, once in the conceptualizer, once after grammatical and phonological encoding and finally after articulation. If an error is detected at one of these three points, the message is interrupted and looped back around to the conceptualizer where the production process starts from the beginning. It is also important to note that monitoring requires constant attention involving the three networks of attention: Speakers must be alert, to a certain degree, in order to orient focal attention to potential mismatches between speakers' intentions and the emerging message. They must also detect the mismatch and decide what to do about it, that is, execute some sort of self-repair – note that a self-repair could also include abandoning the message all together. The resulting repairs are therefore a manifestation of attention management. The observable nature of repairs makes them a valuable observation window into the cognitive processes involved in speaking (e.g., Griggs, 2003; Kormos, 2006; Royer, 2002).

To summarize, the Blueprint is composed of a conceptualizer where the semantic structure of messages are assembled, a formulator which executes grammatical encoding and articulation, and a self-perception system which allows for the monitoring of production and the execution of self-repairs. In normal L1 speech production, the conceptualization phase places constant demands on attentional resources while the encoding processes of the formulator are high automatic and thus exact few of such resources. As this model was conceived to explain L1 production, it does not account for characteristics of L2 speech such as L1-L2 language selection, the organization of multiple languages in the mental lexicon, and the cohabitation of multiple grammatical encoding systems at varying stages of development. To account for these factors, I will turn to an L2 adaptation of the Blueprint.

1.3.2 L2 adaptation of the Blueprint of the Monolingual Speaker

de Bot (1992) elaborated the first, and arguably the most influential, model of L2 speech production. His objective was to adapt Levelt's Blueprint (1989) by making as few changes as possible to account for phenomena associated with bilingualism. That is, the model had to account for the cohabitation of a potentially unlimited number of linguistic systems, which vary from completely separated to extensively mixed (i.e., code switching), and which vary with regard to L2 proficiency. Therefore, certain parts of the Levelt model remain untouched, while modifications to account for these phenomena were added as needed to other parts.

The first modification that de Bot (1992) made to the Blueprint was in the conceptualizer, which, he claimed, is where bilingual speakers select the language in which the emerging utterance will be formulated and articulated. Levelt (1989) posited that the conceptualizer was language specific, implying that speakers of different languages possessed different conceptualizers. de Bot (1992) offered a somewhat more nuanced explanation. He argued that the macro-planning phase of conceptualization is not language specific, as it relies mostly on encyclopedic knowledge (e.g., Ottawa is the capital of Canada), which is shared between languages. It is the micro-planning phase, where the propositional skeletons of utterances are elaborated in accordance with the morphosyntactic interface of lexical items from the selected language, that is language specific.

As for the formulator, de Bot claims that processes vary on a continuum from a unified to a dual system as a function of L1-L2 linguistic distance and L2 proficiency. For example, a Spanish-speaker who has just learned a few sentences in French, a language that is linguistically close to Spanish, will likely have one Spanish formulator. However, as the learner increases in proficiency, a separate French formulator will emerge. Ultimately, each language possesses its own formulator.

While the formulator is language specific, de Bot argues for a unified mental lexicon in which lexical access is governed by spreading activation, whereby lexical elements have "a certain number of characteristics and must be stimulated to a certain level in order to become activated" (de Bot, 1992, p. 12) and selected for inclusion in an emerging utterance. One of the activation characteristics is language selection, which allows for efficient L1 and L2 lexical access, and therefore does not imply a deceleration of L2 processing. Subsequent research examining code-switching behavior among 45 Dutch L1 English L2 speakers of various proficiency levels

(Poulisse & Bongaerts, 1994) bolsters de Bot's unified lexicon hypothesis. One problem that emerges from the model, however, is that lexical access occurs in the formulator. How can the roughing out of semantic propositions occur at the micro-planning phase of the conceptualizer, if the conceptualizer does not have access to the syntactic interface features of the elements of the mental lexicon? This problem can be solved by applying de Bot's (1992) model to Levelt's (1999) update of the Blueprint, in which he created a link from the conceptualizer to the lemma pool of the lexicon and another link from the formulator to the morpho-phonological codes pool of the lexicon. An updated version of de Bot's model would thus include links from the formulator and the conceptualizer to a unified mental lexicon.

With regard to articulation, based on the observation of persistent L1 influence on L2 articulation (i.e., the presence of a "foreign" accent), de Bot (1992) argues "there is only one articulator for bilingual speakers which has an extensive set of sounds and pitch patterns from both languages to work with" (de Bot, 1992, p. 17). That is to say, L2 articulation is extracted from an L1 articulator containing approximate L2 variants of sounds that do not exist in the L1. This claim has also been supported by cases from Poulisse and Bongaerts (1994) where Dutch L1 speakers accidentally accessed Dutch words during English L2 production and encoded them using English L2 phonological procedures. The authors claimed that such errors would be improbable if the articulator were language specific.

Finally, de Bot (1992) does not go into detail about the speech-comprehension system (i.e., monitoring system) of the model he proposes. He simply states that "if we propose that each language has its own formulator, it would seem natural to assume a separate speech-comprehension system for each language as well" (de Bot, 1992, p. 17). I would, however, nuance this statement by adding that the comprehension system monitors both language specific and non-language specific processes. I would, therefore, argue that the system is language specific when responding to targets from language specific components such as micro-planning and formulation and non-language specific when triggered by non-language specific components such as macro-planning and articulation. I will go into detail about self-repair typologies in section 1.6.2.

To summarize, de Bot (1992) proposed an L2 speech production model that remained remarkably close to that of the Blueprint. It comprises a non-language specific macro-planning phase, language specific micro-planning and formulator phases, and a unified L1-L2 lexicon and articulator.

Looking at the role of attention through the lens of Levelt's Blueprint and de Bot's (1992) adaptation allows us to make some specific claims. We can identify four general parallel processes that all require varying degrees of attentional resources. For L1 speakers, macro-planning conceptualization is a stable consumer of resources while the micro-planning, formulation and articulation processes, which are so automatic that they are virtually unavailable to conscious awareness, consume few resources. Such automatic processes engender few errors, thus lightening demands required for monitoring. L2 speakers, on the other hand, experience greater variation in terms of the level of automatization of these processes and the attentional resource demands they exact. These controlled processes generate more errors and thus increase demands on monitoring resources. L2 speakers thus find themselves in a situation where they have to manage the allocation of a greater quantity of resources to a greater number of processes than L1 speakers. In the next section, I will elaborate a model illustrating the role of attention in L2 and L1 speech production based on the theoretical framework of attention presented in section 1.2 and the L1 and L2 production models presented in 1.3.

1.4 Attention and speech production

In this section, I will return to the attention models presented in section 1.2 with the aim of designating a model that best explains attention and both L2 and L1 speech production. I will therefore consider Filter Theory (e.g., Broadbent, 1958), limited-capacity single-resource models (e.g., Kahneman, 1973), limited-capacity multiple-resource models (e.g., Wickens, 1980, 1984, 2007), and unlimited models based on selection-for-action (e.g., Allport, 1998).

The early stages of attention research in SLA (e.g., Schmidt, 1990; Schmidt & Frota, 1986) were, at least implicitly, influenced by Broadbent's Filter Theory. In a very well-known study, Schmidt and Frota (1986) used journaling and regularly recorded interviews to document Schmidt's acquisition of Portuguese as a second language. The findings of their study revealed that all the novel elements that Schmidt produced during the interviews could be traced back to documentation in his learning journal. Such observations prompted Schmidt (1990, 1993, 1995, 2001) to make the strong claim that SLA cannot occur subconsciously, which is congruent with early selection theories in that only input that has been selected for further processing comes into conscious awareness, that is, attention. According to his *Noticing Hypothesis*, learners must select and attend to novel elements from the linguistic environment in order for those elements to become intake for further processing and integration into the learners developing system. There is no SLA without attention. Noticing has since become a critical element in many influential SLA models (e.g., Bialystok, 1994; Gass, 1997; Robinson, 1995; VanPatten, 1996), all of which conceive of attention as selective and as a limited resource.

The traditional SLA conception of attention was elaborated with specific regard for language acquisition and does not speak explicitly of the role of attention in L2 speech planning and production. This raises questions concerning how Filter Theory might be applied to L2 speech production. As was illustrated in section 1.3, language production requires the allocation of attentional resources to various parallel processes such as message conceptualization, grammatical encoding, articulation and self-monitoring. As Filter Theory is based on selectivity and limited capacity, it would characterize these processes as operating serially, requiring rapid, continuous shifting between them. It does not therefore account for the parallel processing characteristic of speech production. For example, if message conceptualization requires constant attention (de Bot, 1992), Filter Theory does not account for the continuous monitoring and self-correction of production that appear to occur seamlessly in parallel. Additionally, Filter Theory does not explain the modulation of attentional demands (i.e., effort) brought about by variation in task complexity and variation in the level of automaticity of the processes involved in speaking. Such questions beg the consideration of a more flexible model of attention, elaborated with explicit regard for the parallel processing evident in speech production and for the role of variation in attentional demands and automaticity.

Limited-capacity single-resource models, such as the one put forth by Kahneman (1973), appear to respond to this need. Recall that Kahneman likened attention to a generator whose resources can be distributed across many parallel processes until those resources are depleted. Task decrement is thus a result of insufficient resources. Such a model appears to be supported by findings in SLA (e.g., Gilabert, 2007; Foster & Skehan, 1996; Skehan & Foster, 1997; Tarone, 1983, 1985; VanPatten, 1990). For example, VanPatten (1990) investigated the role of dual task performance using a comprehension task and a secondary task consisting either of monitoring for a specific lexical item or a particular grammatical form (i.e., determiners or grammatical morphemes). He reasoned that if the primary task were based on comprehension, then the lexical item identification task would interfere with the comprehension task less than would the grammatical form identification task, the latter exceeding attentional capacity limits. This reasoning was borne out by his results. VanPatten (1996) would later formally argue that learners first process input for meaning and secondly for form only if attentional resources remain. With regard to speech production, Tarone (1983) similarly argued that during speech production attention is shared between message conceptualization and formulation (i.e., grammatical encoding). As task demands increase, less attention is allocated to grammatical encoding, as manifested by a decline in accuracy. In other words, if a given task requires more effort at the level of conceptualization, fewer resources are available for grammatical encoding, articulation and self-monitoring.

Such limited-capacity single-resource models appear to account for SLA as well as the parallel processing characteristic of L2 speech production. They do not, however, account for how some tasks can seemingly be performed simultaneously with little or no interference, while others can only be carried out together with great difficulty. Given that execution of the speech production processes outlined in section 1.3 range from effortless to effortful as a function of proficiency, inclusion of an explanation for this variation into a model would be essential. Multiple-resource models offer such an explanation.

Let us recall that Wickens (1980, 1984, 2007) proposed a model that depicts attention as composed of multiple resource pools defined according to three dimensions: perceptual modality (visual, auditory), coding format (verbal, spatial), and processing stage (perception, cognition, responding). If one attempts to assign the subtasks of speaking to resource pools as suggested by Wickens' (1984) model, one might place message conceptualization in the cognition stage of the visual/spatial pool. The processing of linguistic form might draw from the responding end of the verbal/auditory pool. Finally, as speakers monitor their own speech using the same system they use to monitor the speech of others, the self-perception system would draw on the perceptual end of the auditory/verbal pool. In L2 speech production, these processes vary with regard to the effort they require for proper execution, that is, they vary on a continuum from controlled to automatic processing. Controlled processes require constant attentional resources while automatic processes are involuntary, parallel and unconscious, and thus operate relatively free of such resources (DeKeyser, 2007; Kahneman & Treisman, 1984; Posner, 1978; Regan, 1981; Segalowitz, 2000). In normal L1 speech production, for example, attention is drawn largely from the visual/spatial/cognition pool (conceptualization), a process which never fully automatizes, while little attention is needed for the perception and responding stages of the audio/verbal pool (morphophonological encoding, articulation and monitoring) because the associated encoding processes are fully automatized. Accordingly, the speaker makes few encoding errors (Segalowitz, 2010), which in turn lightens the load on self-monitoring. On the contrary, the controlled encoding processes characteristic of L2 speakers place heavy demands on those corresponding resources. The controlled state of those processes generates more disfluencies (Kormos, 2006), thereby increasing demands on the monitoring processes that draw on the perceptual end of the auditory verbal pool.

As they account for the parallel processes involved in L2 speech production as well as variation in the effort required to execute those processes, limited-capacity multiple-resource models appear to represent the role of attention in L2 speech production. Robinson (2005), however, criticizes a fundamental notion on which such theories are based: Using an argument similar to that of Allport (1998), he claims that the selective nature of attention is not due to limited capacity, but rather to speakers' inability to effectively orchestrate the parallel processes involved in language use. He thus attributes disfluencies in speech production to inefficiency "of control functions during central processing (i.e., allocation policy, time constraints on scheduling attention allocation), and interference occurring during resource allocation to those specific task demands which central processing responds to" (Robinson, 2005, p. 646). For the present study, I have defined such efficiency as *attention management.*

To illustrate attention management, it helps to consider the role that the functions of attention (i.e., alertness, orientation, detection) would play during speech production. For example, the orientation network would allow speakers to disengage attentional resources from a previous fixation on a given linguistic element (e.g., a production error) in order to redirect those resources to new sources of language production data so as to filter out non-candidates (non-errors) for detection by the executive network. Harnessing the short-term memory, the executive network would then detect errors and execute corresponding repairs. Levels of alertness would interact with the activity of the other networks. That is, alertness for the monitoring of errors would drop as the executive network detects an error and executes a repair: The norepinephrine effect ensures that these two functions do not interfere with each other (Posner & Raichle, 1994). Alertness would, however, facilitate orientation and subsequent detection by enhancing concentration of attentional resource levels to appropriate sources of data. The efficiency of the complex coordination that occurs between the functions of attention is attention management.

From this perspective, a model of attention that can accommodate both Wickens' (1984, 2007) notions of multiple attentional resources and Allport's (1998) model based on selection-for-action would best represent the role of attention in L2 speech production, which is an attention management task. The present study is therefore anchored in a multiple-resource model based on selection-for-action, which would predict that variation in individuals' capacity to efficiently allocate attentional resources, not an individuals' brute attentional capacity, is involved in speech production. Demands on attention-management capacity would therefore vary in accordance with the levels of automatization of the processes involved. Accordingly, in unautomatized L2 speech production, one would predict that efficient attention management skills would result in improvements in the functioning of the various speech production processes. Conversely, decrements in performance would thus be the result of a failure to efficiently allocate those resources (i.e., attention-management), which, in itself, is a manifestation of the efficient coordination between the three interdependent attention networks, that is, alertness, orientation, and detection.

1.5 Synthesis

Various themes emerge out of this theoretical framework on attention and L2 speech production. These include the characteristics and functions of attention in speech production (1.5.1), the role of attention in the various stages of speech production (1.5.2), the use of self-repairs to observe attention allocation (1.5.3).

1.5.1 Characteristics and functions of attention in speech production

The first theme highlighted in our theoretical framework concerned the characteristics and functions of attention. The models presented in this chapter illustrate the considerable variation that exists in the field with regard to explanations of the limiting nature of attention and to the conceptualization of the coordination between its multiple functions. Those models are summarized in Table 1.1.

Table 1.1. Summary of the attention models

Model of attention	Author	Characteristics
Early selection filter models	Broadbent (1959)	Attention acts as a limited capacity filter protecting central processing. Only selected input enters into consciousness.
Late selection filter models	Deutsch & Deutsch (1963)	Attention acts as a limited capacity filter, but all input stimuli must be fully identified before passing through a limited-capacity attentional system.
Limited-capacity single-resource models	Kahneman (1973)	Attention is a limited capacity resource that can be split between two simultaneous tasks as long as the demands of those tasks do not exceed resource capacity limits.
Limited-capacity multiple-resources models	Wickens (1984)	Attention consists of multiple limited-capacity resources pools that can be shared between two simultaneous tasks as long as the demands of those tasks draw on separate resource pools and do not exceed resource capacity limits.
Multiple-resource models based on selection-for-action	Allport (1998)	Attention consists of multiple unlimited resource pools, wherein task decrement is a result of a lack of coordination between resources.

While research on the role of attention in SLA is, at least implicitly, based on limited-capacity filter theories of attention, we argued that such a conception is not congruent with the nature of the parallel processing involved in speech production. As speaking is rather an attention-management activity (de Bot, 1992; Levelt, 1989), we argued that these processes are better explained by a multiple-resource model based on selection-for-action, which would predict that task performance is a function of speakers' capacity to effectively manage the allocation of resources among multiple parallel processes without much cross-talk. We suggested that such attention management is a manifestation of efficient coordination of the alertness, orientation and executive attentional networks.

1.5.2 Role of attention in the various stages of speech production

The second aspect highlighted by the theoretical framework was related to the distribution of attentional resources according to the de Bot (1992) and the Levelt (1989, 1999) production models. Attention is required in varying degrees for the proper functioning of all speech production processes (i.e., message conceptualization, formulation, articulation and monitoring). Such variation is a function of L1 and L2 processing (Bange & Kern, 1996; van Hest, 1996) and levels of L2 development (Kormos, 2000a, 2000b; O'Connor, 1988; van Hest, 1996; Verhoeven, 1989). Furthermore, a trend emerges in the literature supporting de Bot's (1992) claim that the conceptualization stage of production is a constant consumer of attentional resources for both L1 and L2 speakers of all proficiency levels, while the formulator processes gradually consume fewer of these resources as those processes automatize: As proficiency increases fewer resources are allocated to the form of utterances freeing up more resources for allocation to its semantic content.

1.5.3 Use of self-repairs to observe attention allocation

The next aspect concerned the use of self-repairs as an observation window into the allocation of attention during speaking. Audible repairs that are both initiated and executed by the speaker are a direct result of monitoring production, an attention-consuming task. One would therefore expect self-repairs to vary in tandem with the efficiency of the allocation of attentional resources to the multiple speech production processes. The observation of these repairs thus offers researchers the possibility to document attentional resource allocation during speech production (Griggs, 2003;

Kormos, 2006; Royer, 2002). In the next section, I will therefore present a review of the L2 self-repair literature.

1.6 Self-repairs

In this section, I present a formal definition of self-repairs (1.6.1), followed by a review of the literature defining various self-repair typologies (1.6.2) as well as the structure (1.6.3) of self-repairs.

1.6.1 Self-initiated self-repairs: A definition

Overt self-initiated self-repairs can be defined along three dimensions: the initiator of the repair, the executor of the repair and the pre- or post articulatory status of the repair. The *initiator* is the person who first attends to the error that triggered the repair, that is, either the speaker or the interlocutor. Schegloff, Jefferson and Sacks (1977) coined these categories as self- and other-initiated repairs. *Self-initiated* repairs constitute instances whereby the speaker halts his own speech and initiates a repair. These repairs represent the allocation of attention to possible gaps in the speaker's own linguistic knowledge. *Other-initiated* repairs, or repairs initiated by interlocutors, do not represent such allocation. One can also isolate the *executor* of the repair. For this distinction one can refer to repairs completed by the speaker as *self-repairs* and those executed by the interlocutor as *other-repairs*. Only self-repairs represent the allocation of attention on the part of the speaker. Finally, repairs can occur either pre- or post-articulation. Levelt (1989) refers to the former as *covert repairs.* Since these repairs occur before articulation, they are usually observed as pauses, hesitations, false starts and fillers that break the flow of fluent speech. While covert repairs are also an indication of metalinguistic activity and thus the allocation of attention (e.g., Berg, 1986; Blackmer & Mitton, 1991; Griggs, 1997, 2002; Levelt, 1983, 1989; Postma & Kolk, 1992, 1993; Postma, Kolk, & Povel, 1990), their prearticulatory nature makes them difficult to investigate without a self-reporting protocol (Kormos, 2006). *Overt repairs*, on the other hand, are the verbalized form of their covert counterparts (Levelt, 1989). These self-repairs can be in response to the identification of errors or mismatches between speakers' intentions and the emerging utterance stemming from all points of the production process, but, being realized post-articulation, they can be observed.

Salonen and Laakso's (2009) definition of self-repairs takes into consideration all of these dimensions and will therefore be used as the working definition for the present study. The authors define *self-repairs* "as revisions of speech that the speakers themselves had initiated and completed" (p. 859). This definition implies that the repair is overt, thus observable. Additionally, the speaker not only initiates, but also executes the modification. This definition thus allows us to interpret self-repairs as an indicator of that to which interlocutors are allocating attention when reformulating an utterance. Finally, Salonen and Laakso's definition does not imply that all self-repairs are in response to an error, which is congruent with well-documented observations (e.g., Levelt, 1983). Considering these three dimensions, overt self-initiated self-repairs (hereafter, self-repairs[7]) offer a valuable window into the cognitive processes involved in speaking. Indeed, authors of many L2 speech production studies have used self-repairs for such a purpose (i.e., Arroyo, 2003; Camps, 2003; Fathman, 1980; Gilabert, 2007; Griggs, 1998, 2007; Kormos, 2000; Lennon, 1984, 1990; O'Connor, 1988; Simard *et al.*, 2011; Verhoeven, 1989).

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[7] For the sake of brevity, I use the terms repairs or self-repairs in this text to refer only to post-articulatory repair initiated and executed by the speakers, that is, overt self-initiated self-repairs. I will refer to all other repairs types by their full name.

1.6.2 Self-repair typologies

The development of a typology of repair types was another concern for early speech production researchers (e.g., Levelt, 1983; Brédart, 1991). The earliest work in this field, which laid the theoretical groundwork on which most subsequent L1 and L2 self-repair research in the field would be based, was conducted by Levelt (1983). His objectives were to develop a profile of the types of repairs native-speakers make in spontaneous speech in order to contribute to the development of a coherent speech production and monitoring theory: The Blueprint for the Monolingual Speaker.

To meet his objectives, Levelt analyzed a corpus of 959 self-repairs spontaneously made by 53 native-speakers of Dutch during a description task in which the participants had to describe varying patterns of colored disks linked by lines. To create the repair-type profiles, repairs were initially coded into three broad categories: *different-repairs* (D-repairs) where speakers abandoned the interrupted utterance in favor of an entirely new utterance; *appropriacy-repairs* (A-repairs) where speakers modified the interrupted utterance in order to rectify perceived ambiguities in the emerging message; and *error-repairs* (E-repairs) where speakers corrected an error detected in the emerging utterance. E-repairs were further subdivided into lexical (EL-repairs), syntactic (ES-repairs) and phonetic (EF-repairs) repairs. Levelt points out that both D- and A-repairs attend to perceived discrepancies between intentions elaborated in the conceptualizer and the emerging message at either the pre- (i.e., inner-speech) or post-articulatory stages. By contrast, E-repairs are triggered by errors produced in the formulator perceived either pre- or post-articulation. Among the results, D-repairs represented a mere 1% of the reformulations while A-repairs accounted for nearly a third (30%). E-repairs, on the other hand, were by far the most common (42%). Among the E-repairs, most (38% of all repairs) were in response to erroneous lexical items while syntax repairs were quite rare (2% of all repairs).

Over the years, numerous researchers have elaborated typologies based on the original Levelt (1983) study. For example, Brédart (1991) added *repairs for good language* to Levelt's A-repair subcategory.[8] The researcher also added two E-repair subcategories, one to account for repairs where new words were added to the utterance and the other to account for the elision that commonly occurs between two vowels in French. In 1996, Bange and Kern added E-repair categories for repairs targeting gender and morphology. Based on the self-repair behavior of 30 Hungarian ESL students, Kormos (1998) created a whole new category to account for the rephrasing phenomenon she observed in her L2 data. She also refined the D-repair category with the addition of a category to explain instances where speakers totally abandon a message for lack of linguistic knowledge. Kormos also modified the A-repair category with a subcategory to account for pragmatic errors.

Most of these typologies illustrate an attempt to refine Levelt's model. Numerous other studies have, however, created their own typologies. O'Connor (1988), for example, coded for lexical, tense, pronunciation, and agreement repairs, while Verhoeven (1989) investigated semantic, syntactic, and phonological repairs. In a study on L1-L2 code switching, Poulisse & Bongaerts (1994) simply divided self-repairs into content and function word categories. Griggs (1998, 2002) created three categories to code the self-repairs observed in his studies: He accounted for conceptualizer repairs (similar to Levelt's A and D repairs), lexical access repairs (similar to Levelt's EL repairs) and formulator repairs (similar to Levelt's E repairs). More recently, Simard *et al.* (2011) distinguished between form repairs (F-repairs) and choice repairs (C-repairs). *F-repairs* result in a correction to the linguistic form

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[8] Instances where "speakers replaced a term or an expression which was correct, but either did not fit canonical good French or was not well-suited to the social situation" (Brédart, 1991, p. 127).

of an utterance (e.g., gender, number, or conjugation errors in French) and *C-repairs*, on the other hand, result in the change of a linguistic element (e.g., word and determiner choice in French). While these self-repair categories appear to be quite different from those proposed by Levelt, they too distinguish between discourse-level repairs (conceptualizer) and repairs to linguistic form (formulator): O'Connor's (1988) lexical repairs, Verhoeven's (1989) semantic repairs, Poulisse and Bongaerts' (1994) content repairs, and Simard *et al.*'s (2011) C-repairs would fit into Levelt's (1999) notion of the conceptualizer, while all other repairs would stem from formulator errors. In fact, the conceptualizer/formulator distinction appears to be the principle theme that runs through all self-repair studies.

1.6.3 Characteristics of self-repairs

A significant part of early self-repair research was preoccupied with learning about the structure of self-repairs. Some researchers (e.g., Nooteboom, 1980; Levelt, 1983; Blackmer & Mitton, 1991; Brédart, 1991) were interested in understanding how and where speakers interrupt their utterances in relation to the repair target (1.6.3.1). Other research (e.g., Levelt, 1983; van Wijk & Kempen, 1987) was focused on understanding the structure of the relationship between the repair and the reparandum, that is, how and where speakers begin repairs with regard to error detection and production cut-off (1.6.3.2).

1.6.3.1 Utterance interruption

Building on early psycholinguistic research using speech errors to create sentence generation models (e.g., Fromkin, 1973; Garrett, 1975), Nooteboom (1980) aimed to determine where speakers interrupt their speech upon detection of errors and how far they backtrack into the original utterance when correcting those errors. Nooteboom used data from a German corpus of speech errors (Meringer, 1908), from which he extracted 415 self-repairs, and for which he calculated repairs-type frequencies, speech interruption points and repair points.

Nooteboom's (1980) results showed that speakers only interrupt their speech in the middle of a word if that word is the *reparandum*, that is, the target of the repair. These within-word interruptions were even more frequent when reparandi were erroneous. In other words, if the reparandum was grammatically correct, and the ensuing repair was conceptual in nature, speakers completed the word. Interruptions occurring after the reparandum, however, always respected word boundaries. Nooteboom (1980) also found that interruption was related to repair types: An immediate cut-off within the reparandum was observed for 90% of phonological errors while that figure was 80% for lexical errors. The author suggested that the phonological errors were more salient to the speakers and thus available for immediate detection. Finally, concerning the repairs points, Nooteboom found that 97% of repairs respected word boundaries, that is, they began with a word and not a morpheme, even for within-word interruption of the reparandum. There was very little backtracking for phonological repairs, 93% of which began at the point of interruption. By contrast, in 42% of lexical errors, speakers backtracked to include words preceding the reparandum of the original utterance. Nooteboom suggested that cut-off timing is driven by two opposing forces: "one stemming from the urge to correct the error immediately and the other from the urge to complete the word in the process of being spoken" (Nooteboom, 1980, p. 94). He further suggested that when detection occurs within the reparandum the first urge supersedes the second, while the contrary is true for post-reparandum detection.

Levelt (1983) expanded on Nooteboom's work, conducting a more fine-grained analysis of the timing of interruption and repair points of the self-repairs from the same corpus he used to develop his typology. His analysis led him to develop the *Main Interruption Rule* (MIR), whereby speakers "stop the flow of speech immediately upon detecting the occasion of repair" (Levelt, 1983, p. 56). At first glance, however, Levelt's data seemed to contradict the very rule he was stating. First, the results showed cases of delayed within-word interruptions, which ran contrary to Nooteboom's (1980) claims. Secondly, analyses showed that 74% of immediate cut-offs and 66% of delayed cut-offs occurred at the end of constituent boundaries rather than within the reparandi at the source of trouble, suggesting that speakers are not urged to immediately interrupt speech upon detection of an error as previously argued.

To explain these conflicting results, Levelt hypothesized that detection increases toward the end of constituents. Thus, it is detection that is delayed and not interruption. To test this hypothesis, he compared correction rates for errors at various distances (in syllables) from the end of their respective constituents. He found that repairs rates did indeed increase from about 15% in non-final position to 57% in final position. This finding led Levelt to maintain the MIR by positing that detection "depends in part on the position of trouble in the constituent being processed" (Levelt, 1983, p. 60).

Levelt (1983) also needed to explain why only 26% of immediate cut-offs occurred within the reparandum. His data showed that within-word cut-offs accounted for 23% of repairs to erroneous trouble words (i.e., E-repairs), while this was the case for only 7% of non-erroneous repairs (i.e., D- and A-repairs). Speakers appear to only interrupt an utterance within-word when the word in question is erroneous (i.e., E-repairs). To conclude, Levelt amended a second qualification to the MIR, that is, "only erroneous words may be interrupted upon detection of the occasion for repair" (p. 56).

Levelt's claims were bolstered by Brédart's (1991) study in which he analyzed the cut-off and repair points in the same data used for the typology study. The distribution of interruption points was very similar to that of Levelt's study. Brédart also confirmed that within-word interruptions were significantly more frequent in immediate interruption cases (26.2%) than late interruption cases (8.8%). Based on

Levelt's delayed-detection theory, Brédart hypothesized that within-word interruptions would be more frequent in longer words than shorter words. Indeed, word completion fell as the word length increased. However, this trend disappeared when only A-repairs were entered into the model, which appears to be in support of Levelt's position on delayed cut-offs for non-erroneous reparandi. To test this position, Brédart calculated frequencies of erroneous and non-erroneous within-word interruptions and found that only 2.6% of the repairs in his corpus did not behave according to this rule. Brédart's finding lent solid support to the MIR.

Findings from Blackmer and Mitton (1991), however, challenged the rule. Aiming to test the validity of the most prominent speech production theories of the day (i.e., Laver, 1980; Berg, 1986; Levelt, 1983, 1989), these researchers compared differences in error-to-cut-off and cut-off-to-repair times for 1525 repairs produced by 61 native English-speaking callers to a recorded Canadian radio talk show. The conversational turns were transcribed. Errors and speech cut-offs were identified, and repairs were coded according to Levelt's (1983) classification scheme. With regard to the MIR, 19.2% of repairs were instantaneous, that is, with cut-off-to-repair times of 0 milliseconds, suggesting that detection and repair planning occurred before the cut-off. While Blackmer and Mitton (1991) cast doubt on the MIR, they conclude that Levelt's speech production model best explains their results, contingent on the inclusion of articulatory buffer through which pre-articulatory inner-speech can be monitored.

1.6.3.2 Repair architecture

In contrast to MIR research aiming to explain the underlying rules governing where speakers interrupt their speech upon detection of an error, the goal of the research presented in this section was to identify rules regulating the repair proper. One of the earliest contributors to this work was Levelt's (1983) seminal study, in which he elaborated what became known as the *Well-Formedness Rule* (WFR). Levelt defined the rule as follows.

> A repair <*a y*> is well-formed if and only if there is a string *ß* such that the string <*aß and* y*> is well-formed, where *ß* is a completion of the constituent directly dominating the last element of *a*. (Levelt, 1983, p. 78)

Levelt provides the following example of a well-formed repair (A) to illustrate the rule.

(A) $\overbrace{\textit{to the right is a green,}}^{a}$ $\overbrace{\textit{a blue node}}^{y}$

(B) $\overbrace{\textit{to the right is a green}}^{a}$ $\overbrace{\textit{node}}^{ß}$ *and* $\overbrace{\textit{a blue node,}}^{y}$

The letter *a* indicates the original utterance, which was interrupted after the word *green*, and *y* indicates the repair. Example B shows that the word *node* (*ß*), which is the string needed to complete the final noun phrase constituent of the original utterance (*a*), is also present in the repair (*y*). The addition of the word *and* completes a grammatical coordination, where the same constituent structure appears on both sides (i.e., <*aß and* y*>). In his corpus data, Levelt found that 98% of all repairs, excluding the Rest and Syntactic Error repairs, conformed to the WFR.

To critically test Levelt's rule, van Wijk and Kempen (1987) used a picture description task to elicit 2060 self-repairs, during which the pictures were modified to elicit repair targets consisting of prepositional phrases (PP) containing a postposed noun phrase (NP). They reasoned that the WFR would predict that speakers retrace to the beginning of the PP when formulating repairs following immediate interruptions and to the beginning of the NP following delayed interruptions. Their data suggested that there are two mechanisms governing the structure of self-repairs (e.g., reformulation and lemma substitution) and that reformulations are the only type of repair that conforms to the WFR. *Reformulations* were synonymous with Levelt's A-repairs, whereby all or part of the structure of the original utterance was replaced by a new structure. *Lemma substitutions*, on the other hand, only entailed the substitution of a lexical element from the original utterance and were thought to be governed by the phonological phrase rather than by the syntactic structure of the utterance. The authors concluded that the restrictive nature of Levelt's (1983) data collection scheme resulted in stilted self-repair behavior. In response, Levelt (1989) later called for "further scrutiny of naturalistic data [...] to substantiate the systematic occurrences of such repairs" (p. 489).

While evidence supporting the MIR and the WFR is not conclusive, the trends emerging from the early work on the structure of self-repairs validate suggestions that they are governed by underlying cognitive traits.

Several themes emerge out of the self-repair research presented in this section. First, the operational definition of self-repairs as post-articulatory repairs initiated and completed by the speaker renders them a manifestation of the allocation of attention on the part of speakers during speech production. Secondly, repair typologies allow researchers to identify the stages of the speech production process (i.e., conceptualizer and formulator) to which speakers allocate attention. Finally, regularity in the architecture of self-repairs lends credence to claims that they are governed by underlying cognitive processes, one of which should be attention-management. In the next section, I will turn specifically to L2 self-repair research that has investigated such links.

1.7 L2 speaker-centered self-repair research

In the introduction, I outlined the distinction between language-centered speech production studies, which focus on the relationship between self-repairs and variables external to speakers such as language and task-type, and speaker-centered studies, which include variables internal to speakers such as proficiency, linguistic development and cognitive capacity. The present study is based in the later of these two domains.

In this section, I present research investigating the relationship between language proficiency and the distribution and frequency of self-repairs (e.g., Kormos, 2000a, 2000b; O'Connor, 1988; van Hest, 1996; Verhoeven, 1989) (1.7.1). These studies shed light on how repair behavior changes as proficiency increases. I then turn to studies examining links between self-repairs and L2 development (e.g., Golonka, 2006; Griggs, 1997, 2003) (1.7.2). Unlike the proficiency studies, these researchers speculate a causal link between self-repairs and development whereby the former influences the latter. I will finally present studies postulating that self-repairs are governed by individual cognitive traits such as non-verbal intelligence (e.g., Verhoeven, 1989), monitoring preferences (e.g., Kormos, 1999b), memory (e.g., Fincher, 2006) and attention (e.g., Fincher, 2006; Simard *et al.*, 2011) (1.7.3).

1.7.1 L2 Proficiency and self-repair behavior

Studies examining the proficiency variable use self-repairs as a means of understanding that to which L2 speakers pay attention and how the object of attention varies according to proficiency level.

In the first study of this kind, O'Connor (1988) set out to observe the self-repair behavior of three beginner and three advanced American French L2 students that had been living in Bordeaux for six months. She was specifically interested in examining the relationship between proficiency and the number and types of repairs L2 speakers make. The self-repair data was collected from 45-minute recorded conversations between each participant and the researcher. The repairs were divided into *corrective repairs*, that is, repairs to form (i.e., E-repairs), and *anticipatory repairs*, which are oriented to the level of discourse (i.e., A-repairs and D-repairs). She found that the beginner and advanced speakers produced about the same number of repairs, but the advanced students' repairs tended to be more discourse oriented (i.e., anticipatory repairs) while the beginner students' repairs tended to target structural errors more frequently. O'Connor explains that the automatized lower level processes of the advanced students freed up attentional resources that could then be used to monitor discourse-level features.

There was one exception in O'Connor's data. One advanced student targeted more lower-level linguistic features than the other participants. O'Connor explains that the participant's desire to become a French instructor likely influenced the distribution of attention to such features, suggesting that self-repairs not only interact with individuals' proficiency levels, but also with their mental state, or more specifically, with their motivation and goals with regard to the L2.

In a two-year longitudinal study, Verhoeven (1989) examined the self-repair behavior of 74 Dutch L2 Turkish children ages six to eight and of various proficiency levels. The self-repair data were collected through discussion and picture-cue narration tasks. Participants also completed a test measuring their Dutch L2 linguistic accuracy. The self-repairs were identified and coded as restarts (i.e., D-repairs), corrections (i.e., E-repairs) and repeats (i.e., the repetition of all or part of an utterance). The repairs were further classified as phonological, syntactic or semantic in nature. Restarts decreased from age six to seven and then leveled out between seven and eight. Repeats, by contrast, increased gradually over the two years. With respect to corrections, semantic corrections increased significantly over the two years while phonological corrections dropped sharply from six to seven, leveling out from seven to eight. Syntactic repairs were very infrequent from six to seven, increasing slightly from seven to eight. In line with O'Connor's (1980) findings, Verhoeven's results show that as speaker proficiency increases repair behavior transitions from form to discourse level features.

van Hest (1996) looked at the role of proficiency on the frequency, distribution, and timing of self-repairs. She recruited three groups of Dutch-speaking pre-university students varying according to proficiency in ESL: low (n = 10), intermediate (n = 10) and advanced (n = 10). Participants completed a picture-cued narration task in both their L1 and L2 followed by a 20-minute interview with a native speaker of the respective languages. The researcher collected 45 hours of discourse, in which 4700 self-repairs (2079 L1 and 2623 L2) were isolated, transcribed, and classified using Levelt's (1983) taxonomy. Repair rates were then calculated based on the number of words produced during the narration. The data revealed the emergence of a two-staged development. The lower and intermediate levels produced about the same number of repairs, which was statistically higher than the number produced by the advanced group. This finding was in contrast to O'Connor's (1980) observation of equal repair frequency between the low and high groups. However, corroborating O'Connor's (1980) results, van Hest found that the lower groups produced more EL-repairs and fewer A-repairs than the advanced group. Furthermore, with respect to repair structure, the lower groups interrupted their errors earlier than the advanced group. van Hest suggested that the controlled processes of the low-proficiency speakers are easier to interrupt than those automatic processes of advanced speakers. Comparison of her L1 and L2 data reveals that as speakers gain in L2 proficiency their self-repair profiles tend toward those of L1 speakers. This is in line with recent studies on fluency (e.g., Derwing, Munro, Thomson, & Rossiter, 2009; De Jong, Schoonen, & Hulstijn, 2009), which reveal a relationship between L1 and L2 speech production. These findings support the claim that there are underlying traits that govern speech production in both languages.

Kormos (2000a) also looked at the relationship between proficiency and the timing of repairs. She recruited 30 Hungarian ESL students of various proficiencies (advanced, upper-intermediate and pre-intermediate). Self-repair data were collected through a five-minute role-play activity, followed by a 20-minute retrospective interview. The repairs were classified using the Brédart (1991) and Levelt (1983) taxonomies (i.e., A-repairs, E-repairs, D-repairs and Rephrasing). Error-to-cut-off, cut-off-to-repair, and length of the reparatum were measured in milliseconds. In general, complex repairs took longer to execute than simple repairs. Similar to Blackmer and Mitton (1991), E-repairs had shorter error-to-cut-off and cut-off-to-repair times than A- and D-repairs. Kormos argues that according to Levelt's model (1989), self-monitoring uses the same system that speakers use to monitor the speech of others. Thus, self-monitoring is a question of comprehension. Since grammatical decoding processes occur lower and earlier on the language comprehension hierarchy than semantic processes, they are detected more quickly. Kormos' findings corroborate both L1 (i.e., Blackmer & Mitton, 1991) and L2 results (i.e., Verhoeven, 1989), which also found faster error-to-cut-off times for phonological than semantic errors. Regarding repair-types, high proficiency speakers made fewer E-repairs and more A-repairs than the less proficient speakers. This finding supports those of O'Connor (1980) and van Hest (1996). High proficiency speakers also executed A-repairs and E-repairs more quickly than less proficient speakers. Again, this is likely a result of automatization.

The same year, Kormos (2000b) aimed to investigate how L2 speakers at various competency levels "manage their attention resources while monitoring for grammatical and lexical accuracy, the informational content of their message and the contextual features of their utterance" (p. 346). To answer her question, Kormos recruited 40 Hungarian pre-intermediate and advanced ESL speakers. Self-repair data were collected through a role-play task. This was followed by a retrospective interview. Self-repairs were coded using taxonomies developed by Brédart (1991) and Levelt (1983), and errors were identified and divided into grammatical and lexical errors. Kormos' results show that L2 speakers' attention is in general roughly divided between discourse-level and grammatical-encoding repairs, but in line with O'Connor (1980) and Van Hest (1996), as speakers become more advanced they make a greater proportion of discourse-level repairs. Similar to other researchers, she attributes these finding to the automatization of formulator processes.

In a small study, Arroyo (2003) analyzed and recorded conversations of two French L2 learners at different proficiency levels. Using Bange and Kern's (1996) typology, the researcher coded the self-repairs produced during the conversation. Contrary to results from similar studies, the low proficiency learner made more discourse-level repairs than the advanced learner, and the reverse trend was the case for grammar repairs. However, these results cannot be generalized to a larger population of language learners due to the very small number of participants.

In general, the results regarding the relationship between proficiency and repair frequency are not wholly conclusive: van Hest (1996) found that lower-proficiency speakers make more errors and thus more repairs while O'Connor (1980) did not find significant differences. What does appear to be certain, however, are findings concerning the relationship between proficiency and repair distribution. Novice speakers tend to focus attention on lower-level discourse features generated in the "here and now" while advanced speakers attend to more discourse-level features, the latter requiring the capacity to attend to the past events of the discourse model and to predict the direction of their discourse. Novice speakers also appear to interrupt errors more quickly and execute repairs more slowly than advanced speakers. The researchers (i.e., Kormos, 2000a, 2000b; O'Connor, 1980; van Hest, 1996, Verhoeven, 1989) point to the automatization of lower-level encoding processes to account for these trends. That is, as a result of such automatization, more attentional resources are freed up for discourse-level monitoring. There is also some evidence that motivational factors, such as individuals' goals with regard to the language, may also play a role in attention allocation during production, suggesting that factors governing self-repair behavior can be overridden by learning objectives and motivation.

1.7.2 L2 development and self-repair behavior

Along the same lines as the proficiency studies, the studies presented in this section have also focused on the relationship between self-repairs and language proficiency. They differ, however, in that they position self-repairs as the independent variable acting on linguistic development as the dependent variable. More succinctly, these researchers (i.e., Golonka, 2006; Griggs, 1997, 2003) set out to answer questions concerning the role of self-repairs in the promotion of linguistic development.

In his 1997 study, Griggs compared the self-repair behavior of six pairs of French ESL students performing various communicative tasks and L2 development spread out over the course of an academic year. Participants were divided into two groups: a *frequent repair group* making more than one self-repair for every 40 words and an *infrequent repair group* making less than one self-repair for every 40 words. Griggs then compared the two groups according to their progress in fluency (words per minutes) and accuracy measures (rate of lexical and morphosyntactic errors per number of words). The fluency results revealed that the frequent repairers improved slightly more than the infrequent repairers, but this difference was not significant. Griggs speculates that the increase in time spent on form as a result of frequent self-repairing does not lend itself to fluency development. The accuracy results, on the other hand, show that the frequent repairers made significantly more progress than the infrequent repair group. In a follow-up study, Griggs (2003) reanalyzed data from the 1997 study in order to see if the frequent repair group's progress could be attributed to what Færch and Kasper (1983) refer to as *reduction* behavior, that is, a simplification of one's discourse to avoid errors. A discourse complexity ratio using

T-units[9] did not reveal any significant differences between the groups. Griggs argues that speakers who self-repair more frequently benefit from more metalinguistic activity and therefore develop grammatical competency more quickly.

Golonka (2006) provides further evidence of the benefits of self-repairs on L2 development. She links self-repairs with *executive function*, which she defines as "the ability to monitor and control the use of knowledge, and which is an ability that plays a significant role in successful learning and academic achievement" (Golonka, 2006. p. 498). To determine if self-repairing is related to improved acquisition outcomes, she analyzed the data of 22 under-graduate English-speaking university students participating in a semester abroad in Saint-Petersburg, Russia. All students were evaluated at the high-intermediate level on the Oral Proficiency Interview (OPI) in Russian upon entry into the program. She divided the participants into two groups according to their OPI results at the end of the semester: ten gainers who moved up a level according to the test, 12 null gainers who either maintained or dropped to a lower level. The researcher then analyzed speech samples from the warm-up and level-check stages of the OPI. To operationalize executive function, she coded for self-corrections and sentence repairs. Self-repair was defined as "the number of errors that were corrected by the students themselves while speaking" (Golonka, 2006, p. 500) and "sentence repair referred to backtracking and to syntactic changes in sentences made by the students themselves" (Golonka, 2006, p. 500). The gainers self-repaired more than twice as frequently as the null-gainers. The sentence repair variable was also a self-repair variable whose target was specifically syntactic errors.

[9] Griggs (2003) defines T-Units as "*une proposition principale et toute proposition subordonnée qui lui est attachée*" (p. 6).

For this category, the gainers self-repaired almost four times more frequently than their null-gainer counterparts.

The proficiency studies presented in the previous section provide evidence that self-repairs change as a result of linguistic development. What the work presented in this section adds to that body of work is the knowledge that self-repairs also contribute to that development. We can speculate that the erroneous features targeted by the self-repairs benefit from the allocation of attention that is associated with those repairs.

1.7.3 Variation in individual cognitive traits and self-repair behavior

The speaker-centered research presented thus far has focused on variation among individuals with specific regard to the developmental state of their L2. By contrast, the studies presented in this section have focused on self-repairs and variation in individual cognitive traits such as memory, attention, and attitudes about monitoring. This research is based on two assumptions: 1) Self-repairs are an overt representation of the cognitive processes involved in production. 2) The capacity of such cognitive processes varies among individuals. Researchers in this area therefore hypothesize that self-repair behavior will also vary according to variation in cognitive capacities.

In a study aiming to uncover temporal and structural aspects of L2 monitoring, Verhoeven (1989) investigated the relationship between the self-repair behavior and the non-verbal intelligence of 74 Turkish L1 Dutch L2 children between ages six and eight. Self-repair data were collected through a picture-cued narration task, and the measure of non-verbal intelligence was operationalized using the Raven's Progressive Matrices. Task execution was recorded and transcribed. Self-repairs, which were defined "as interruptions of an utterance, followed by a reformulation or repetition of part or all of the utterance" (Verhoeven, 1989, p. 145), were coded into the following categories: restarts (i.e., interruption of an utterance in favor of a new one), corrections (phonological, syntactic, semantic), repetition of utterances. Results showed relatively small significant correlations between non-verbal intelligence and restarts (.27), repeats (.22), and syntactic (.18) and semantic corrections (.22). Phonological repairs, however, did not exhibit a relationship. The author concluded that "the mental strategy for repairs other than phonological corrections is positively related to general cognitive skill." (Verhoeven, 1989, p. 150).

Kormos (1999b) set out to measure the interaction of the effect of variation in the individual speaking habits and self-repairs of three groups of ten Hungarian ESL students at three proficiency levels (advanced, upper-intermediate, pre-intermediate). The researcher elaborated a questionnaire designed to measure whether participants "attribute more importance to the precise and accurate expression of their thoughts than to fluent and quick delivery of their message, and whether they are bothered by making mistakes in their speech" (Kormos, 1999b, p. 211). The fluency-oriented speakers were labeled as *monitor-under-users* while the form-oriented speakers were grouped as *monitor-over-users*. To elicit the repair data, participants performed a meaning-focused role-play task followed by an introspective interview where they were asked to reflect on their self-repairs. The Levelt (1983) and Brédart (1991) taxonomies were used to group the self-repairs. Fluency levels and total error-to-correction rates were then calculated. Results showed an expected positive correlation between monitor-under-users and fluency. Regarding self-repairs, the monitor-over-users produced significantly more rephrasing repairs. Correlation analyses also showed that the form-oriented speakers corrected more lexical errors, but as many grammatical errors as their fluency-oriented counterparts.

One could deduce that Kormos' (1999b) results point to individual variation in executive attention insofar as the differences in the participants' linguistic goals manipulated the alertness and orientation functions of attention therefore influencing the allocation of attention in order to maximize the realization of such goals. As the study did not include a psychometric measure of executive functions, such an argument remains speculative (Kormos, 1999b, p. 219).

In a more recent study, Fincher (2006) investigated the effects of individual differences in attentional and memory capacity and the self-repair behavior of five Japanese L2 learners, one of whom was the researcher. Fincher audio recorded seven hours of in-class interaction. Recordings were transcribed and coded using a taxonomy elaborated by Kormos (1998), in which she integrated L2 specific content into Levelt's (1983) taxonomy. To collect attention and memory data, Fincher used a questionnaire designed to measure participants' perception of their own attentional resources and a computer-administered test designed to measure attention and memory, in which learners had to hold instructions in the short term memory before their application. Fincher's results did not reveal a relationship between the observed self-repair behavior and scores from her measures of attention and memory. However, considering the small sample size of her study, it is possible that a lack of statistical power did not allow for the emergence of potential relationships in her data. Additionally, her attention data were derived from a questionnaire where participants evaluated their own capacity. The small number of participants and the validity of the measurement tools make it difficult to draw any conclusions from this study.

In a follow-up to Fincher, Simard *et al.* (2011) attempted to answer these same questions linked to attention by resolving some of the methodological issues of her study: Their study included 23 university-level advanced French L2 students; self-repair data were collected using an elicited narration task; and attentional capacity was operationalized using the d2 Test of Attention, a test designed to measure participants' ability to maintain concentration on a task. The self-repair data were identified and coded according to a form-meaning distinction. The researchers then correlated the repair ratio – the raw number of self-repairs to the total number of words produced during the narration task – and results from the d2 Test of attention. Similar to Fincher (2006), the results of this study did not reveal any significant correlations between the two variables. To explain their results, Simard *et al.* (2011) argued that limiting a study on the role of attention in self-repairs to variation in attentional capacity likely fails to offer a complete picture of this role. Indeed, as speech production is an attention-management task (De Bot, 1992; Levelt, 1989), the researchers argue that an examination of a possible link between a processual measure of attention (Tognoli & Toniolo, 2003) and self-repair behavior might lead to a clearer picture of the crucial role of attention in self-repairs, and more broadly, in L2 language production.

While the body of research on the variation of cognitive traits among individuals is more recent and less conclusive than the work presented in other branches of speaker-centered research, results from Verhoeven (1989) and Kormos (1999) do suggest the presence of such a relationship. Some of the inconclusiveness is likely a result of internal validity issues associated with elaborating tools to effectively measure cognitive differences. The questionnaires used by Kormos (1999) and Fincher (2006), for example, only offer indirect approximations of such differences, as they are in fact measures of perception. The instrument used by Simard *et al.* (2011) only measured one aspect of attention, that is, the ability to maintain focused concentration for an extended period of time.

Table 1.2 offers a summary of the speaker-centered self-repair research presented in this section. Among the findings in this vein of research, studies investigating the relationship between proficiency and self-repair behavior (i.e., Arroyo, 2003, Kormos, 2000a, 2000b; O'Connor, 1988; van Hest, 1996; Verhoeven, 1989) are by far the most numerous and the most conclusive. With the exception of Arroyo's small study, findings consistently show that low-proficiency speakers make more grammatical encoding repairs and fewer discourse-level repairs than high-proficiency speakers. Additionally, as speakers' proficiency increases their self-repair profiles tend to move toward those of native speakers. Studies investigating the causal relationships between self-repairs and L2 development (i.e., Golonka, 2006; Griggs, 1997, 2003) also provided significant results. Taken together with the proficiency studies, these results provide indirect evidence for the claim that speech production and ensuing self-repairs are governed by underlying cognitive traits. Since speech production is an attention-management activity, one could reasonably expect self-repair behavior to vary according to attentional capacity. With regard to attention, however, the research is relatively new and remains inconclusive. The inconclusiveness of this work possibly stems from insufficiently large sample sizes (e.g., Fincher, 2006) and the validity of the measurement instruments used. The inclusion of other psychometric measures along with larger participant sample sizes would likely help fill in some of the gaps in this field of self-repair research.

Table 1.2. Summary of speaker-centered self-repair research

Authors	Subjects	Objective	Data Elicitation	Repair Categories	Main Findings
Arroyo (2003)	1 beginner and 1 advanced Spanish-speaking French L2 adult	To investigate the influence of proficiency on self-repair behavior	Recorded conversation	A-repairs, D-repairs, E-repairs.	The low proficiency learners made more discourse-level repairs than the advanced learner, and the reverse trend was the case for grammar repairs.
Fincher (2006)	5 English-speaking Japanese L2 adults	To investigate the effects of individual differences in attentional and memory capacity on self-repair behavior	Recorded classroom interaction	A-repairs, D-repairs, E-repairs	There was no significant relationship between memory, attention and self-repair behavior.
Golonka (2006)	22 English-speaking Russian L2 adults	To determine if self-repairs are related to improved acquisition outcomes	Pre- and Post-Oral Proficiency Interview (OPI)	N/A	The OPI gainers self-corrected more than twice as frequently as the null-gainers.
Griggs (1997)	12 French ESL adults	To investigate the effect of self-repairs on L2 development	Communicative tasks	N/A	The frequent repairer made significantly more progress than the infrequent group.
Griggs (2003)	12 French ESL adults	To see if the gains in accuracy of frequent repairers is a result of reduction	Communicative tasks	N/A	Frequent repairers' gains in accuracy are not due to reduction but to benefits from self-repairs
Kormos (1999)	30 Hungarian ESL adults of various proficiencies	To measure the effect of variation in monitoring attitudes on self-repair behavior	Role-play task and introspective interview	A-repairs, D-repairs, E-repairs	Monitor over-users produced more rephrasing and lexical repairs but just as many grammatical repairs as monitor under-users.
Kormos (2000a)	30 Hungarian ESL adults of various proficiencies	To determine the effect of proficiency on the repair type, frequency and timing	Role-play task and introspective interview	A-repairs, D-repairs, E-repairs	High proficiency speakers made fewer E-repairs and more A-repairs than the less proficient speakers.

Kormos (2000b)	40 pre-intermediate to advanced Hungarian ESL adults	To learn how speakers of various proficiencies manage their attention while monitoring production	Role-play task and introspective interview	A-repairs, D-repairs, E-repairs	As speakers become more advanced they make a greater proportion of discourse-level repairs.
O'Connor (1988)	6 beginner and 6 advanced French L2 adults	To investigate the effect of proficiency on the number and type of self-repairs L2 speakers produce	45-minute recorded conversation with the researcher	Anticipatory discourse-level repairs; Corrective grammatical repairs	Both groups made about the same number of repairs. Lower proficiency speakers made more grammatical repairs and high proficiency speakers made more anticipatory repairs
Simard, Fortier & Zuniga (2011)	23 intermediate French L2 adults	The relationship between attention and the frequency and type of self-repairs	Picture-cued narration task	Form repairs, Choice repairs	There was no significant relationship between attention and self-repair behavior.
van Hest (1996)	30 beginner to advanced Dutch ESL adults	To investigate the effect of proficiency on L2 self-repair behavior	Picture-cued narration task	A-repairs, D-repairs, E-repairs	The lower and intermediate levels produced more repairs than the advanced group. Lower groups produced more EL-repairs and fewer A-repairs than the advanced group.
Verhoeven (1989)	74 Turkish Dutch L2 children of various proficiency levels	To determine the effect of proficiency on the type of repairs L2 speaker make and to see if there is a relationship between non-verbal intelligence and self-repairs	Discussion and picture-cue narration tasks.	Restarts, Repeats, Corrections (phonological, syntactic, semantic)	As speaker proficiency increases, repair frequency transitions from form to discourse level features. There were also slight but significant correlations between restarts (.27), repeats (.22) and semantic corrections (.22) and non-verbal intelligence scores.

1.8 Synthesis: self-repairs, attention and L2 production

In the second half of this chapter, I reviewed the literature on self-repairs with the intent of showing how they can be used to observe attention. I presented a review of the research that contributed to the elaboration of various self-repair typologies and descriptions of the timing and shape of self-repairs. This work laid the foundation on which much L2 self-repair research is based. I finally reviewed the speaker-centered self-repair research, which has focused on variables internal to speakers such as proficiency, linguistic development and cognitive capacity. I will now conclude this chapter with a presentation of my research questions and the formulation and justification of my hypotheses.

1.9 Research questions and hypotheses

The main objective of the present study is to verify whether a link exists between variation in self-repair behavior during L2 speech production and attention-management capacity. With the understanding that L1 and L2 speech production is governed the same underlying traits, and that those traits are meditated by L2 proficiency in L2 production, a secondary objective was also established to determine the role of these co-variables respectively. I have defined attention during speech production as drawing simultaneously on multiple-resources, which, depending on levels of automaticity, operate in a selective manner that is the result of interference originating from inefficiencies in coordinating multiple-resource use rather than capacity limitations. I refer to such coordination as attention-management. I argue that attention-management is governed by underlying cognitive traits that influence operations in the alertness, orientation, and executive attention networks. Figure 1.3 depicts a model of how I conceptualize attention-management during speech production.

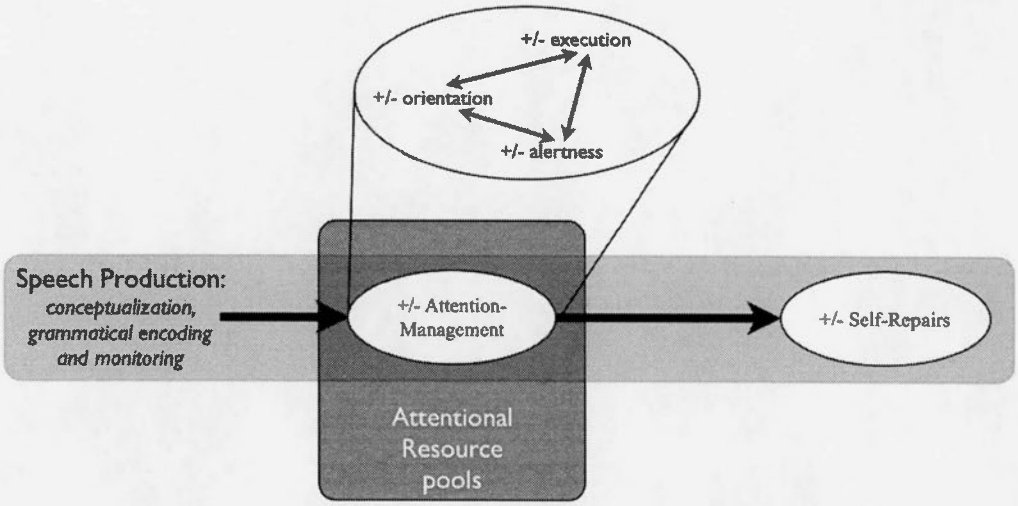

Figure 1.3. Model representing the relationship between attention and speech production used for the present study

As established in this chapter, speech production requires attention-management skills. The best way to observe attention-management during speech production is to observe attention allocation through monitoring and the resulting self-repairs. In the model, the production processes are represented by the grey bar. All processes pass within perceptual reach of the attentional resources pools. Automatized processes pass through, demanding little or no attentional resources, while unautomatized processes draw on the multiple attentional resource pools to varying degrees. The efficiency with which such resources are allocated depends on attention management, which itself varies as a function of the efficiency of the interplay between the three attentional networks, that is, alertness, orientation and execution. Such variation can be observed through the observation of self-repairs. According to this model, one would predict that greater attention-management capacity would translate to more efficient attention allocation and therefore more efficient language processing and a lower frequency of self-repairs.

Since I conceptualize attention as a cognitive trait that functions independent of language use, I also expect L1 self-repair behavior to be a mediating factor in L2 self-repair behavior. Furthermore, since L2 speakers experience vast variation in formulator and lexical-access processing efficiency, which can range on a continuum from controlled, placing heavy demands on cognitive resources, to fully automatized, operating largely free of those resources, I also expect the L1-L2 repair behavior link to be modulated by L2 proficiency. Such a theoretical framework permits me to formulate the following research questions:

> Q1: Is there a relationship between attention management capacity and self-repair behavior in L2 speech production?
>
> Q2: If there is a relationship between attention management capacity and self-repair behavior in L2 speech production, is this relationship mediated by L2 proficiency level and L1 self-repair behavior?

In order to predict the outcomes of the research questions, I have formulated the following hypotheses. This will be followed by justifications based on the literature review.

> H1: Participants with high attention-management capacity will produce fewer self-repairs than participants with lower attention-management capacity.
>
> H2: The relationship between attention-management capacity and self-repairs will be mediated by the participants' L2 proficiency level and L1 self-repair behavior.

1.9.1 Justification of hypothesis 1

Speaking is an attention management activity in which success depends on how well speakers coordinate resources between multiple parallel processes (Levelt, 1989). Monitoring and the resulting self-repairs constitute the part of this attention-management process that can be observed (Kormos, 2006). We know that individuals vary with respect to self-repair behavior (e.g. Griggs, 1988; Kormos, 1999b; Simard *et al.*, 2011); that is, some people self-repair more often than others. We also know that people vary along the lines of attentional capacity (Mackey, Philip, Egi, Fukii & Tatsumi, 2002). We therefore might reasonably predict that there will be a relationship between these two variables. Additionally, studies examining the structure of self-repairs show that there are regularities in both L1 (e.g., Blackmer & Mitton, 1991; Brédart, 1991; Levelt, 1983; Nooteboom, 1980) and L2 repairs (e.g., Bange & Kern, 1996; van Hest, 1996), and as L2 speakers gain in proficiency their repair profiles begin to reflect those of L1 speakers. Furthermore, self-repair behavior has been shown to vary in accordance with L2 development (e.g., O'Connor, 1988; Lennon, 1984; van Hest, 1996; Verhoeven, 1989). There appears to be a trend in both languages of a redirection of attentional resources from lower-level encoding to high-lever conceptualization processes as speakers develop cognitively and linguistically. Such regularities point to the existence of underlying cognitive governing traits. While studies attempting to examine these traits show that variation among individual with respect to non-verbal intelligence (e.g., Verhoeven, 1989) and monitoring attitudes (e.g., Kormos, 1999b) show modest relationships, the findings concerning the role of attention remain inconclusive: Research on the role of brute attentional capacity (e.g., Fincher, 2006; Simard *et al.*, 2011) did not reveal any interaction with self-repairs. It can be argued, however, that these studies did not target critical processual aspects of attention concerning speech production, that is, speakers' capacity to manage their attentional resources.

1.9.2 Justification of hypothesis 2

The role of proficiency has attracted much attention in L2 self-repair research. Indeed the research documenting relationships between self-repair and proficiency (e.g., Kormos, 2000a, 2000b; O'Connor, 1988; van Hest, 1996; Verhoeven, 1989) and linguistic development (e.g., Golonka, 2006; Griggs, 1997, 2003) have revealed significant relationships effecting behavior both quantitatively and qualitatively.

Inclusion of the proficiency variable in this study is essential in that none of these studies offer clues as to the role that attention plays in the proficiency-repair relationship.

With regard to L1 repair behavior, while L1 and L2 comparison studies of self-repair behavior have been conducted (Bange & Kern, 1996; van Hest, 1996), these studies focused on L1-L2 differences. They did not seek correlations between L1 and L2 behavior so as to determine whether speakers behave similarly in L1 and L2 (Do frequent L1 repairers repair frequently in L2?). In this same vein, consideration of recent fluency studies that have found relationships between L1 and L2 speech production qualities (i.e., Derwing, Munro, Thomson, & Rossiter, 2009; De Jong, Schoonen, & Hulstijn, 2009) suggesting that L1 and L2 fluency are governed by the same underlying cognitive processes. One might therefore also expect to find a relationship between L1 and L2 self-repair behavior.

CHAPTER II

METHOD

2.1 Introduction

As stated in the previous chapter, the primary objective of the present study was to investigate the link between attention management capacity and L2 speech production through the observation of self-repairs. As a secondary objective, I aimed to determine if such a link is also mediated by L2 proficiency and L1 self-repair behavior. In this section, I will outline the experimental plan developed to test my hypotheses. I will first present an overview of the experimental design (2.2) and the variables (2.3). I will then present the participants (2.4) and measurement instruments (2.5), followed by the preparation process (2.6), data collection (2.7) and coding (2.8) procedures. I will finally present the data analysis procedures (2.9), followed by a synthesis of the methodology (2.10).

2.2 Design

The present study followed an L1-L2 parallel design through which I was able to look for relationships between the attention-management scores and the self-repairs of 58 participants (native French-speaking intermediate-to-advanced English L2 speakers) produced during elicited narrations in both French L1 and English L2. Each participant performed a series of tasks chosen to measure the study's variables.

2.3 Variables

The independent variable was attention-management capacity, as measured by the Trail Making Test. The dependent variables were the quantity and the quality of self-repairs. The quantity variable was operationalized through the calculation of an aggregate self-repair rate; that is, the ratio of the brute number of self-repairs over the pruned speech rate, which itself was based on a count of only the words in the participants' discourse conveying new information (Griggs, 1997, p. 410). I operationalized the quality variable by identifying repairs according to the conceptualizer and the formulator subcategories. Finally, the control variables were the participants' L1 and their ESL proficiency.

2.4 Participants

For the present study, 58 native French-speaking ESL speakers of various proficiency levels participated in the study. I recruited the participants from several undergraduate and graduate programs at a French-speaking university in Montreal, Canada. I initially screened the participants to ensure that they met the French L1 and English L2 criteria. In order to be considered native French-speaking, participants had to report having grown up in a household in which French was the exclusive language and in which neither parent was a native English-speaker. Furthermore, participants also had to report having been educated in French-speaking primary and secondary schools. Finally, students of psychology were excluded from the study, as these participants might have had previous exposure to the psychometric measures used in the study.

Among the 58 participants, 19 were men and 39 were women. The average age was 28.7 years (max = 48; min = 18). On average, the participants started learning English at 8.9 years of age. As for their actual daily English usage, 22% reported never using English, 41% reported speaking English less than one hour per day, 28%

claimed to spend between one and fours hours per day in English, while 9% reported presently living primarily in English. The participants had largely favorable attitudes toward English, which was reflected by an average score of 8.9 on a scale of 1 to 10, with 10 representing the most positive attitude. All but three participants rated learning English as very important. With respect to education, 49 participants were enrolled in an undergraduate university program. Among the remaining participants, 8 were in a master's program, and one was completing a PhD. Concerning their program of study, the participants fell into one four categories: Teaching English as a Second Language, Teaching French as a second language, Linguistics, Other.

2.5 Measurement instruments

Four instruments were used to collect data for the study: A questionnaire designed to obtain demographic information and details about the participants' relationship with English as a second language (2.5.1), a proficiency test (2.5.2), the Trail Making Test (2.5.3), and narrations elicited in French (L1) and English (L2) (2.5.4).

2.5.1 Questionnaire.

The questionnaire (Appendix A.1) targeted socio-demographic information and details about the participants' past and present experience with English as a second language. The questions elicited information about the age of initiation of ESL studies, English usage outside of school as a child, the frequency and nature of their present day use of English as adults, their attitudes about the language in general.

2.5.2 Proficiency test

I used a cloze procedure to gather data regarding participants' proficiency level in English as a second language. This procedure consists of a text of approximately 375 words wherein every seventh word has been deleted and replaced with a blank space, with the exception of the first and last sentences of the text (Aitken, 1975). The cloze is known as an integrative test because it tests all aspects of language (vocabulary and grammar) in a single test (Brown, 2004, p 8). Several researchers have found high correlations between the procedure and more elaborate proficiency tests. For example, Oller (1972) found a correlation of (.75) and (.83) between the cloze and the ESL exam used at the University of California, Los Angeles, and Stubbs and Tucker (1975) reported a correlation of (.76) for the English Entrance Examination of the American University of Beirut. Furthermore, the cloze procedure is practical, as it can be quickly constructed and administered, and offers a high level of rater reliability (Brown, 2004, p. 202).

The cloze for the present study (Appendix A.2) was built from a 387-word text. The story was presented in double-spaced type with every seventh word deleted and replaced by equally sized spaces for responses. There are also no deletions in the first and last sentences of the text. Finally, the instructions were adapted according to Aitken's (1975) recommendations and appeared at the top of the text sheet.

2.5.3 Trail Making Test.

Let us recall that Simard *et al.* (2011) did not find a link between attention and self-repairs using the d2 Test of Attention, which is a measure of individuals' capacity to sustain concentration of attentional resources across time while attempting to quickly detect an incoming target within a flood of non target items in the input. Such a measure does not indicate how individuals coordinate attention while conducting two simultaneous tasks similar to that of L2 speech production wherein speakers must allocate resources to multiple parallel processes. To obtain this measure, I used the Trail Making Test (TMT), which is a widely used neuropsychological test found in most test batteries (Tombaugh, 2004). Originally known as the Divided Attention Test, it was first developed in 1938 by Partington and Leiter (1949) for the US War Department as part of the Army Individual Test Battery. It was validated early on as tool for detecting patients with brain damage (e.g., Reitan, 1955, 1958), and has more recently been validated in the detection of frontal lobe deficits (Yochim, Baldo, Nelson, & Delis, 2007), executive control in set shifting (Arbuthnott & Frank, 2000) and attention (e.g., O'Donnell, MacGregor, Dabrowski, Oestreicher, & Romero, 1994). The test is composed of two sections. Test A consists of encircled numbers from 1 to 25 scattered randomly on the page. Participants are instructed to connect the circles quickly and efficiently using a pencil. Test B consists of a series of encircled numbers and letters that must be connected following an alternating pattern (i.e., 1-A-2-B-3-C-4-D, etc.). This second test is more complex as it requires *set-shifting*, that is, a shifting of cognitive resources between two consecutive tasks. Indeed, participants must not only shift attention around a page to identify randomly dispersed target items, but also shift attention between a number and a letter task. Among the two tests, Test B has been shown to be a more sensitive indicator of executive control and set-shifting (Arbuthnott & Frank, 2000) and will therefore constitute the score that will be used to operationalize attention-management for the study.

2.5.4 Elicited narrations.

Self-repair data were elicited through a picture-cue narration task. Elicited narrations have frequently been used to gather relatively realistic speech samples, while maintaining some control over the language elicited (Rossiter, Derwing, & Jones, 2008). Additionally, several studies (e.g., Gilabert, 2007; Foster & Skehan, 1996; Slobin, 1996; Lennon, 1990; Simard, *et al.*, 2011; Yuan & Ellis, 2003) have used elicited narrations to study language production. I selected two picture stories with a tight story line and a clear climax and resolution: *Frog where are you?* (Mayer, 1969), and *A boy, a dog, and a frog* (Meyer, 1964). Such criteria have been shown to increase accuracy (Skehan & Foster, 1997; Tavakoli & Foster, 2008) and reduce attentional resources expended on task resolution (Skehan, 1998). In this sense, more attentional resources are directed to language production than to trying to determine the plot of the story. The stories, composed of 24 and 25 images respectively, also meet the evaluation criteria elaborated in Rossiter, Derwing and Jones (2008).

Table 2.1 offers a summary of the data elicitation tools.

Table 2.1. Summary of the data elicitation tools

Tool	Purpose
Questionnaire	Demographic information and details about participants' history with English
Cloze Procedure	ESL proficiency
Trail Making Test	Attention-management capacity
Elicited Narrations	Self-repair data elicitation

2.6 Data collection preparation

2.6.1 Setting up the laboratory

In an effort to make the experiment convenient for the participants and to ensure ideal conditions for data collection, I set up the laboratory on the university campus. It was equipped with one computer containing a PDF reader that was used to display a slideshow of the images for the elicited narrations, and an embedded audio recorder to capture the narrations. The laboratory was also furnished with a back-up mp3 audio recorder, a timer, several sharpened number-two pencils, and the task distribution chart (Appendix A.3), which contained the participants' names, numbers, and group assignments. There was also a manila folder for each participant labeled with the participant's name, number and group. In each folder were labeled copies of the consent form (Appendix A.6), the questionnaire (Appendix A.1), the Trail

Making Test, and a twenty-dollar compensation. Each document was labeled with the participants' name, number, and group.

2.6.2 Writing the instructions

The instructions were printed on a checklist (Appendix A.4) and were read to participants during the initial greeting and explanation of the experiment, and before the questionnaire, the TMT and the narration.

2.6.3 Participant recruitment

In order to recruit the participants described above (see section 2.4), I visited classes in the linguistics and the second language pedagogy departments of a university in Montreal to present the study and circulate a sign-up sheet (Appendix A.5). Additionally, the departmental administration circulated an email containing information about the study to all students within their programs. I contacted potential participants within 24 hours of the first contact with an email containing instructions and a link to an online calendar where they were able to choose a one-hour appointment for the experiment. At scheduling, I entered the participants' names into the Participant Task Distribution form (Appendix A.3), on which they were assigned a participant number and group (A, B, C, D) determining the elicited narration task order (e.g., Group A: Time 1 = French narration with text A; T2 English narration with text B). I then recorded the appointment times on the participants' folders. The pertinent documents contained in those folders were labeled with the participant's name, number and group. Finally, I sent the participants a reminder email 24 hours before their scheduled appointment.

2.6.4 Piloting

Hatch and Lazaraton (1991) suggest that, "if instructions are to be given to the people who participate in the research, these instructions must be carefully planned and piloted" (p. 38). Therefore, the data collection procedure, which is explained in detail in the next section, was conducted with five participants prior to the official data collection. During the pilot session, I observed and noted all signs of difficulty concerning the instructions and explicitly asked pilot participants after the presentation of each set of instructions for feedback about their clarity. None of the five pilot participants reported any difficulties understanding the instructions and procedures.

In addition to the clarity of the instruction, the time-consuming nature of our tasks made it necessary to determine if the participants would suffer from an exaggerated fatigue effect during the session. Boksem, Meijmann, and Lorist (2005) found a gradual degradation of participants' ability to efficiency allocate attention during a three-hour sequence of tasks. In light of such findings, at the end of each experimental session during the pilot period, I solicited feedback concerning the length of the experimental sequence. None of the pilot participants reported fatigue.

2.7 Data collection procedure

In this section, I will present details concerning the five steps of the experiment in chronological order. I used a checklist containing instructions to be read to the participants for each of the tasks throughout the experiment (Appendix A.4). Prior to the arrival of each participant, I verified that all the documents in the participants file were labeled with the correct name, participant number, and group (Appendix A.3).

2.7.1 Initial greeting

Participants were met at the laboratory and greeted with a couple of minutes of informal small talk in order to help allay any stress that might arise in reaction to the laboratory setting.

2.7.2 Consent form

The participants read and signed a consent form (Appendix A.6). They were also given the opportunity to ask further questions concerning the study. However, details that might have compromised the validity of the measurement instruments were not provided.

2.7.3 Questionnaire

Following the signing of the consent form, I reviewed the instructions below for the questionnaire with the participants before they completed it:

> *Je vous remercie d'avoir pris du temps pour me faire part de certaines informations à votre sujet et de votre expérience avec l'anglais langue seconde. Les informations que vous nous donnerez seront confidentielles et accessibles seulement dans le cadre de cette recherche.*

They were finally asked if they had any questions before completing the questionnaire.

2.7.4 Proficiency test

For the proficiency measure, I read the following instructions, which were adapted from Aitkin (1975), to the participants before asking them to complete the cloze procedure:

Dans l'exercice suivant, chaque septième mot de ce texte en anglais a été supprimé et remplacé par un trou. Vous devez compléter la phrase avec le mot qui vous semble le mieux aller dans l'espace prévu.

Rappelez-vous :

a. *N'écrivez qu'un seul mot sur la ligne prévue.*
b. *Essayez de remplir chaque trou même si vous devez deviner le mot.*
c. *Vous pouvez laisser vides des trous difficiles et y revenir plus tard.*
d. *Vous ne serez pas pénalisé(e) pour des fautes d'orthographe.*
e. *Veuillez écrire lisiblement.*
f. *Prenez le temps qu'il vous faut pour accomplir la tâche, ce qui normalement exige environ 20 minutes.*

The participants were finally asked if they had any questions before beginning the task.

2.7.5 Trail Making Test

The participants received a copy of the sample version of section A of the TMT. I then read the following instructions, which were adapted from Bowie and Harvey (2006)

Cette épreuve comprend deux tâches. Dans cette première partie, vous devez relier au crayon des nombres par ordre croissant le plus rapidement possible et sans lever le crayon de la page, les nombres étant disséminés aléatoirement sur la page. Si vous faites une erreur, je vous l'indiquerai et vous aurez l'occasion de la corriger. Avez-vous des questions à propos de la tâche avant de la commencer ?

Once the sample section of test A was completed, I explained to the participants that they were about to complete the actual task. I then read them the following instructions before presenting the task sheet:

Cette fois-ci, vous allez effectuer la même tâche, mais avec 25 nombres disséminés aléatoirement sur la page. Avez-vous des questions à propos de la tâche avant de la commencer ?

If they did not have any questions, I asked them to pick up the pencil and to prepare to start the task. Once they were ready, I uncovered test page placed in front of them and immediately started the timer. I paid close attention to their actions during task execution in order to detect and point out errors. In the event of an error, I invited them to return to the origin of the error and to resume the task without erasing or crossing out the erroneous trace. Finally, I stopped the timer the moment they reached number 25.

The participant then completed the sample test B. I placed the sample in front of them and read the following instructions.

Pour cette deuxième épreuve, vous devez relier alternativement des chiffres par ordre croissant et des lettres par ordre alphabétique. Par exemple, commencez par le numéro un (indiquer du doigt) et tracer une ligne jusqu'à la lettre A (indiquer du doigt). Ensuite, tracer une ligne de la lettre A (indiquer du doigt) jusqu'au numéro deux, une ligne du numéro deux jusqu'à la lettre B (indiquer du doigt), une ligne de la lettre B jusqu'au numéro 3 (indiquer du doigt), et ainsi de suite jusqu'à ce que vous arriviez à la fin (la lettre D). Comme pour l'épreuve A, vous devez reliez les pastilles le plus rapidement possible et sans lever le crayon de la page. Si vous faites une erreur, je vous l'indiquerai et vous aurez l'occasion de la corriger. Avez-vous des questions à propos de la tâche avant de la commencer ?

If the sample was completed without problems, I explained to them that they were about to complete the final task before reading the following instructions:

Maintenant, vous allez effectuer la même tâche, mais cette fois-ci avec 13 nombres et des lettres (A à L) disséminés aléatoirement sur la page. Avez-vous des questions à propos de la tâche avant de la commencer ?

If the participants did not have any questions, I uncovered the test sheet and began the timer. As in the previous task, I paid close attention to their moves during task execution in order to detect and point out errors. I finally stopped the timer the moment they reached number 13.

2.7.6 Elicited narration tasks

The participants were finally invited to record a 4- to 5-minute narration in French L1 and English L2 using the narration task described in section 2.5.4. To neutralize any effect of the story or the order in which the narrations were elicited, I assigned the participants to one of four groups and the narration tasks were distributed to the groups in a counterbalanced manner. Group A narrated story A in French followed by story B in English. Group B narrated story B in French followed by story A in English. Group C narrated story A in English followed by story B in French. Finally, group D narrated story B in English followed by story A in French (see Appendix A.3 for the participant task-distribution form).

As mentioned above, L2 language production can strain cognitive resources. Evidence, however, shows that when L2 speakers have pre-task planning time, the cognitive load of the production task is lightened and, as a result, their fluency (e.g., Foster & Skehan, 1996) and the complexity of their output increases (e.g., Crookes, 1989; R. Ellis, 1987; Foster & Skehan, 1996; Ortega, 1999; Yuan & Ellis, 2003). For this reason, participants were given a 5-minute planning period before doing each narration task.

To make sure that the participants took advantage of their planning period, I followed Foster and Skehan's (1996) protocol and encouraged participants to take notes. Additionally, as in Lennon (1990), participants were invited to ask for any unknown vocabulary items in the images. However, they were told that they would not be able to use the notes while reciting their narrations. Finally, I did not encourage the participants to take their time to correct errors as many times as they wish, as in Yuan & Ellis (2003): I wanted to observe their self-repair behavior under the most natural conditions possible. Here are the instructions for the task:

> *En regardant les images sur l'écran devant vous, vous allez devoir raconter l'histoire illustrée par les images en (anglais/français) pendant 4 à 5 minutes.*

Vous avez 5 minutes pour vous préparer. Vous pouvez prendre quelques notes pendant la planification sur la feuille que je vous donne à cet effet, mais vous n'aurez pas le droit de les regarder pendant que vous raconterez l'histoire. Vous avez aussi le droit de me demander des mots de vocabulaire pendant votre préparation.

After the 5-minute planning period, the participants recorded their narrations. Two mp3 recorders were used to gather data so as to avoid any potential technical problems. The same procedures were used to prepare and record the second narration.

2.7.7 Closure of the testing session

Once the narrations were completed, I verified that the consent form was correctly signed and that all documents were properly labeled and gave the twenty-dollar compensation to the participant.

Each session took about one hour to complete. See Table 2.2 for a summary.

Table 2.2. Summary of the test session with approximate times

Stage	Tool used	Time
Initial greeting	Informal conversation	2 minutes
Consenting to participate in the study	Consent form	5 minutes
Socio-demographic information	Questionnaire	5 minutes
Proficiency data	Cloze procedure	15 minutes
Attention shifting data	Trail Making Test	10 minutes
Self-repair data 1	Picture-cued elicited narration	10 minutes
Self-repair data 2	Picture-cued elicited narration	10 minutes
Closure of the testing session	Monetary compensation	3 minutes
Total		60 minutes

2.8 Data entry and coding

In this section, I present the data entry and coding procedures. I first entered data from the questionnaire, the TMT, and the narrations into an Excel spreadsheet, with participants occupying the vertical axis and the dependent and independent variables grouped on the horizontal axis.

2.8.1 Questionnaire

The *age* and the *appreciation of English* values were entered as indicated on the questionnaire as continuous variables. The multiple-choice items were assigned an interval value (i.e., A=1, B=2, C=3, D=4). Finally, a nominal coding system was used to account for the *program of study* variable (i.e., 1 = Teaching English as a Second Language; 2 = Teaching French as a Second Language; 3 = Linguistics; 4 = Other).

2.8.2 Proficiency test

There are two different methods for scoring the cloze procedure: When using the exact word method, points are only accorded when participants choose the same word that was deleted. For the acceptable word method, participants score points with any contextually appropriate response. While Stubbs and Tucker (1975) found near perfect correlations (.97) between the two scoring methods, Oller (1972) suggests that the acceptable word method is better because it correlated more highly with the UCLA ESL placement examination. The cloze test was therefore scored with the acceptable word method using the following criteria taken from Stubbs and Tucker (1975).

> 1) any non-grammatical form (e.g., *he say* for *he says*) would be automatically excluded even though the meaning happened to be exact, and 2) any blank which contained two words was excluded even though the result may have been acceptable semantically. All other contextually- or semantically-acceptable possibilities were accepted (Stubbs & Tucker, 1975, p. 240).

Here are some examples of words that were judged acceptable in the first paragraph of the text used in the study. Note that the original word is underlined in bold print and the acceptable words are in parentheses.

> WHEN MY FAMILY FIRST MOVED to North Carolina, we lived in a rented house three blocks from the school where I would begin the third grade. My mother made friends with one **<u>of</u>** the neighbors, but one seemed enough **<u>for</u>** her. Within a year we would **<u>move</u>** ***(leave, migrate)*** again and, as she explained, there **<u>was</u>** not much point in getting too **<u>close</u>** ***(attached)*** to people we would have to **<u>say</u>** ***(utter)*** good-bye to. Our next house was **<u>less</u>** than a mile away, and the **<u>short</u>** ***(small, little)*** journey would hardly merit tears or **<u>even</u>** ***(dramatic, sad, long, prolonged, formal, hard, painful, heartbreaking)*** good-byes, for that matter. It was **<u>more</u>** ***(sort, kind)*** of a "see you later" situation, **<u>but</u>** ***(yet)*** still I adopted my

> mother's attitude, **as** ***(because)*** it allowed me to pretend that **not** making friends was a conscious choice. **I** could if I wanted to. It **just** wasn't the right time.

The test consisted of 50 items. Calculation of the proficiency test score, therefore, simply involved doubling the number of correct responses, for a total of 100 possible points.

2.8.3 Trail Making Test

Two scores were calculated for the TMT. The general score was calculated by adding the time needed to complete parts A and B of the test, and the attention-management score was the time needed to complete part B exclusively.

I used the part B scores to create high- (n = 20) and low-attention (n = 20) groups. In order to have two groups with distinct characteristics, I included only the top and bottom thirtieth percentiles.

2.8.4 Narration

Extracting the self-repair data from the narration entailed a three-step process. The narrations were first transcribed (2.8.4.1). Self-repair events were then identified in the transcripts and subsequently coded according to a pre-established typology (2.8.4.2). Following inter-rater agreement procedures, the recordings and transcriptions were used to calculate a self-repair ratio (2.8.4.3). These steps are presented in detail in the following sections.

2.8.4.1 Transcriptions

I first transcribed three minutes of the recorded narrations. As in Simard, Fortier and Zuniga (2011), I started the transcriptions after the first 20 seconds of narration; this initial period was allotted to allow the participants to warm-up. To obtain three full minutes of discourse, pauses greater than 2 seconds were not factored into the narration time. About the coding conventions, the transcriptions were written to account for phonetic variation. Additionally, the transcripts included the participant number and the number of words produced during the three-minute stretch of discourse, which was subsequently used to create the self-repair ratio. A research assistant then verified the transcripts and I verified them a third time.

2.8.4.2 Identification and coding the self-repairs

A large variety of coding schemes and typologies have been used to study self-repairs. A challenge is thus finding a common theme that links them all together. Levelt (1983) created the earliest detailed and refined self-repair typology, which to date has been the starting point for many, if not most, L1 and L2 speech production studies. In his seminal model, he defines three types of self-repairs stemming from two distinct stages of speech production. On the one hand, different information repairs (D-repairs) and appropriacy repairs (A-repairs) occur in response to conceptualizer errors. D-repairs refer to instances where the current message is replaced by an entirely new one, while A-repairs occur upon detection of perceived problems with the appropriacy, clarity or coherence of the emerging message. These two types of repairs represent instances of attention allocation to message conceptualization. On the other hand, E-repairs are made in response to errors detected at the level of the formulator. Among E-repairs, Levelt refers to repairs made upon detection of lexical, syntactic or phonological errors. Accordingly, the self-repairs for the present study were coded into two parent categories, that is, conceptualizer repairs (C-repairs) and formulator repairs (F-repairs). The C-repairs were further coded as Different, Appropriacy, Lexical and Determiner repairs, and the F-repairs were coded as Pronunciation, Morphology, which includes any derivational or flexional change to a word's form, and Syntax, which includes any change to the order of words in a sentence. Let us recall that my decision to place

Lexical repairs in the conceptualizer stems from Levelt's (1999) modification of the model. Table 2.3 offers an overview of these coding categories with examples.

Table 2.3. Repair categories

Category	Sub-category	Example
C-repairs	Different	and it's /…/ I didn't catch the frog
	Appropriacy	They /…/ Bobby and Rex spent…
	Lexical	The dog /…/ the boy was looking …
	Determiner	The /…/ a boy, a dog and a frog …
F-repairs	Pronunciation	The fru /…/ frog …
	Morphology	The boy walk /…/ walks …
	Syntax	The frog not /…/ was not in his jar …

The repairs were identified using Salonen and Laakso's (2009) definition as a guideline: Self-repairs are "revisions of speech that the speakers themselves had initiated and completed" (p. 859). Two judges independently coded the identified self-repairs. The coding results were compared, and inter-rater reliability was calculated using Cronbach's Alpha (.879). Finally, the two judges were able to negotiate their differences in order to reach 100 percent agreement.

2.8.4.3 Calculation of the self-repair ratio

The aggregate repair rate per number of words produced by each participant was calculated according to the method used by Griggs (1997), where "only words conveying new information were included, and therefore second parts of repeats, false starts and repeated and reformulated words in repair sequences were discounted, as were meta-comments in" English (Griggs, 1997, p. 410).

2.9 Analyses

In order to find a response to my research questions, a series of analyses were conducted. Using the Microsoft Excel software, the data were prepared for entry into the SPSS statistical package. Descriptive statistics were then calculated to determine the mean, median, standard deviation and distribution of proficiency and TMT scores, and L1 and L2 self-repair ratios. Skewness and Kurtosis ratios were also calculated to discern the symmetry and the flatness of the data distribution for all variables. Aside from offering a description of the data, such analyses allowed me to control for the L2 proficiency variable. Moreover, this step allowed me to determine if the data met assumptions necessary for the ensuing parametric statistical tests.

A second series of analyses were conducted to determine the contribution of the independent variables to L2 and L1 self-repair behavior. Both correlations and regressions can be used to test for relationships between two or more variables. However, while simple correlations do not allow one to make causal claims about such relationships, "regression [...] is a way of predicting performance on the dependent variable via one or more independent variables" (Hatch & Lazaraton, 1991, p. 467). Let us recall that our hypotheses are based on a relationship, in which attention-management capacity predicts self-repair behavior. Therefore, regressions were calculated for L2 proficiency, attention-management capacity and L1 and L2 self-repair data.

Before conducting the regression analyses, a two-tailed Pearson correlation was nonetheless conducted as a prerequisite in order to detect the magnitude of the potential relationships between the dependent and independent variables. Indeed, in order to conduct regression analyses, the data must exhibit a linear relationship that does not exceed a correlation of $r=.70$, therefore mitigating potential problems of multicollinearity within the data (Larson-Hall, 2010, p. 190).

Three regression analyses were conducted. The initial analysis was carried out with L2 self-repair ratios as the dependent variable and attention-management scores as the only independent variable. Furthermore, to determine the magnitude of the contribution of the other independent variables, I performed a hierarchical regression analysis including L2 proficiency, attention-management and L1 self-repair behavior as the independent variables and L2 self-repairs as the dependent variable. As in Lafrance and Gottardo (2005), this type of regression was used in order to observe the predictive power of L2 proficiency and attention management on L2 self-repair behavior before the addition of L1 self-repairs. If L1 and L2 repairs are indeed governed by the same underlying cognitive process, L1 repairs would otherwise likely be revealed as the only significant variable in a standard regression. At last, a regression was conducted to probe the predictive power of attention management on L1 self-repair behavior.

Finally, in order to obtain a more refined picture of the role of attention management and self-repair behavior, repair ratios were calculated for both high- and low-attention management groups. The Mann-Whitney U test was used to determine whether group differences were statistically significant. This is a non-parametric test of the null hypothesis that two independent groups are the same. It is generally used with ordinal data, wherein participants can be ranked in respect to other participants (Hatch & Lazaraton, 1991, p. 274).

2.10 Summary of the experimental plan

Table 2.4 offers a summary of the experimental design.

Table 2.4. Summary of the research plan

Research Question and Hypothesis	
Question 1	Is there a relationship between attention management capacity and self-repair behavior in L2 speech production?
Question 2	If there is a relationship between attention management capacity and self-repair behavior, is it mediated by L2 proficiency, and L1 self-repair behavior?
Hypothesis 1	Participants with high attention-management capacity will produce fewer self-repairs than participants with lower attention-management capacity.
Hypothesis 2	The relationship between attention-management capacity and self-repairs will be mediated by L2 proficiency and L1 self-repair behavior.
Experimental Plan	
A parallel design in which participants with the same L1 took the TMT test of attention and performed a story telling task in both their native and second languages.	
Variables	
Independent	Attention-management capacity
Dependent	Quantity of self-repairs
	Quality of self-repairs
Control	Native Language
	L2 Proficiency
Participants	
58 native French-speaking intermediate to advanced ESL speakers	
Experimental tasks	
Questionnaire	Trail Making Test
Proficiency Test	L1 & L2 Elicited Narration

CHAPTER III

RESULTS

The previous chapter detailed the methodological protocol elaborated for the present study. In this chapter, I will present and interpret the data analysis results with the goal of testing the study's hypotheses in order to answer our research questions. To offer a global portrait of the data, I will first present the results from the attention and L2 proficiency measurements, followed by a presentation of the L1 and L2 corpora data (3.1). I will then present the inferential statistics that allowed me to determine the presence and the degree of predictive power that exists between attention-management, L1 and L2 self-repair behavior and L2 proficiency (3.2). Finally, to investigate the data from another angle, that is, using the untransformed data and non-parametric tests, I will present the L1 and L2 self-repair results for both low and high attention-management groups (3.3). This data offers a more nuanced portrait of the role that attention plays in speech production.

3.1 General description of the results

The objective of this first section is to provide a portrait of the data collected. First, descriptive statistics are presented for the attention and the L2 proficiency measures (3.1.1). This is followed by a detailed description of the size and scope of the L1 and L2 corpora that were elicited through the picture-cued narration technique (3.1.2).

3.1.1 Attention and proficiency data

This section offers a description of the results from the instruments used to obtain measures of attention-management capacity (i.e., The Trail Making Test B) and L2 proficiency (i.e., the cloze procedure). I will first present the distribution data (3.1.1.1) followed by the means and standard deviations (3.1.1.2).

3.1.1.1 Distribution of the attention and L2 proficiency data

Table 3.1 presents figures indicating the normality of the measurement instrument data distribution. This table offers information about the skewness of the data, which indicates the extent to which it deviates from symmetry, and the kurtosis, which is an indicator of the extent of the slope of the data curve. Finally, skewness and kurtosis ratios (skewness or kurtosis level divided by its standard error) are presented as a test of normality (Larson-Hall, 2010).

Table 3.1. Distribution data for the attention and L2 proficiency measures

Test	Skewness (SE = .314)	Skewness Ratio	Kurtosis (SE = .618)	Kurtosis Ratio
Attention Management (*Trail Making Test B*)	.609	1.93	-.272	.44
L2 Proficiency (*The cloze procedure*)	-.608	1.93	.347	.56

Note. SE = Standard Error

Table 3.1 shows that Attention Management was moderately positively skewed while L2 proficiency was characterized by a moderate negative skew. However, data with skewness and kurtosis ratios that fall between -2 and +2 do not violate normality (Larson-Hall, 2010, p. 78). The data is therefore suitable for parametric statistical testing.

3.1.1.2 Means and standard deviations for the attention and L2 proficiency measures

The means and standard deviations for the measurement instruments are presented in Table 3.2. Note that the attention-management scores are presented as the number of seconds needed to complete section B of the test.

Table 3.2. Means and standard deviations for the attention and L2 proficiency data

Test	Mean	Standard Deviation
Attention Management (*Trail Making Test B*)	37.7	9.5
L2 Proficiency (*The cloze procedure*)	62	18

Inspection of the table shows that the present study's participants completed Test B faster than the average of 58.6 seconds for participants from the same age group published in Tombaugh (2004, p. 207). As for proficiency, the mean score for the acceptable word procedure from the cloze used to measure proficiency was 62%.

3.1.2 L1 and L2 self-repairs

This section offers a portrait of the L1 and L2 corpora data, followed by data describing the distribution, means and standard deviations (3.1.2.1) of the brute number of repair-types produced. This section is closed with a general description of the L1 and L2 repair-type ratio data (3.1.2.2).

Table 3.3 contains figures illustrating the size of the L1 and L2 corpora from which the self-repair data were extracted.

Table 3.3. Number of minutes and words for the L1 and L2 corpora

Corpora data	L1	L2
Minutes of Discourse	174	174
Total Words	25,671	21,836

Both corpora are composed of 174 minutes of recorded discourse. Participants produced about 15% more words in the L1 narration (25,671 words) than in the L2 narration (21,836).

3.1.2.1 General description of the brute L1 and L2 repair-type data

This section offers a snapshot of the brute distribution of repairs, that is, before repair ratios were calculated. Table 3.4 presents the L1 and L2 data side-by-side.

Table 3.4. Brute number of L1 and L2 self-repair types

Repair Type	L1		L2	
	Brute	Proportion*	Brute	Proportion*
Total Repairs	367	100	428	100
Total C-Repairs	254	69	319	75
• Different Repairs	49	13	42	10
• Appropriacy Repairs	79	22	83	19
• Lexical Repairs	107	29	167	39
• Determiner Repairs	21	6	26	6
Total F-Repairs	117	31	109	25
• Pronunciation Repairs	31	8	63	15
• Morphology Repairs	77	21	41	9
• Syntax Repairs	10	3	5	1

Note. *The figures are rounded to the nearest percent.

Table 3.4 shows that speakers produced about 17% more repairs in L2 (428 repairs) than in L1 (367 repairs). This figure appeared to increase in tandem with the 17% word-production increase. Among the L1 repairs, speakers produced slightly more than twice as many conceptualizer repairs (69%) as formulator repairs (31%). The proportion of conceptualizer repairs was greater in L2, with speakers producing about three times as many such repairs as formulator repairs. Among the L1 and L2 conceptualizer repairs the proportions were somewhat similar, in that determiner repairs were the least frequent (L1-6%, L2-6%), followed by D-repairs (L1-13%, L2-10%) and A-repairs (L1-22%, L2-19%). D-repairs and A-repairs were slightly more frequent in L1 than in L2. Lexical repairs (L1-29%, L2-39%) were more frequent in L2 than in L1. Taken together, the L1 speakers made more discourse level repairs while L2 speakers made more local lexical repairs. With respect to the formulator repairs, speakers produced nearly twice as many pronunciation repairs in L2 (15%) than in L1 (8%). In contrast to the pronunciation repairs, speakers produced about twice as many morphological repairs in L1 (21%) than in L2 (9%). This figure is likely a result of the rich inflexional morphology that characterizes the French language. Finally, syntax accounted for the fewest number of repairs in both L1 (3%) and L2 (1%).

3.1.2.2 General description of the L1 and L2 repair-type ratio data

Since the brute repair data presented in the previous section do not control for variation in fluency (e.g., false starts, hesitations, repeats and words spoken per narration) among participants, they do not allow for inter-participant and inter-group comparisons of self-repair behavior. Those data were therefore transformed into ratios for each of the repair types by dividing the brute number of repairs by the number of pruned words produced (i.e., truncation of false starts and repeats) during the narration. The descriptive statistics for the L2 (3.1.2.2.1) and L1 (3.1.2.2.2) repair-type ratio data are presented in this section, followed by a comparison of L2 and L1 self-repair behavior (3.1.2.2.3).

3.1.2.2.1 Description of L2 repair-type ratio data

Skewness and kurtosis data for the L2 repair-type ratio data are presented in Table 3.5.

Table 3.5. L2 Repair distribution according to repair-type ratios

Repair Type	Skewness (SE) (.314)	Skewness Ratio	Kurtosis (SE) (.618)	Kurtosis Ratio
Total L2 Repairs	2.339	7.45	6.519	10.55
Total L2 C-Repairs	2.860	9.11	1.658	2.68
• Different Repairs	2.343	7.46	5.595	9.05
• Appropriacy Repairs	1.574	5.01	3.816	6.17
• Lexical Repairs	2.172	6.92	6.101	9.87
• Determiner Repairs	1.725	5.49	2.681	4.34
Total L2 F-Repairs	1.833	5.84	4.066	6.58
• Pronunciation Repairs	1.652	5.26	2.478	4.01
• Morphology Repairs	1.405	4.47	1.193	1.93
• Syntax Repairs	3.359	10.70	10.529	17.04

Note. SE = Standard Error

The figures indicate that none of the ratio data are normally distributed, which is very typical of self-repair data. Total repairs registered a moderate positive skew[10] ($z = 7.4$) and a relatively flat distribution ($z = 10.5$). C-Repairs ($z = 9.1$) were more skewed than F-Repairs ($z = 5.8$), but F-Repairs ($z = 6.5$) were flatter than C-Repairs ($z = 2.6$).

[10] "The skewness ratio is obtained as the skewness statistic divided by the standard error of the skewness statistic" (Weinberg & Abramowitz, 2008, p. 77).

These results indicate that the data will need to be normalized through log transformations in order to be suitable for parametric statistical tests[11].

The means and standard deviations for the L2 repair type ratios are presented in Table 3.6.

Table 3.6. Means and standard deviations for L2 repair-type ratios

Repair Type	Mean	Standard Deviation	Proportion*
Total L2 Repairs	2.27	1.75	100
Total L2 C-Repairs	1.66	1.44	74
• Different Repairs	.22	.39	10
• Appropriacy Repairs	.42	.41	19
• Lexical Repairs	.88	.80	39
• Determiner Repairs	.13	.21	6
Total L2 F-Repairs	.60	.65	26
• Pronunciation Repairs	.34	.44	15
• Morphology Repairs	.22	.31	10
• Syntax Repairs	.03	.09	1

Note. * Figures are rounded to the nearest percentage.

The proportions remain very close to those of the brute repair data. Speakers (n=58) produced 2.27 (1.75) repairs per 100 words. Among the repairs, they produced a rate of 1.16 (1.44) C-Repairs and .6 (.65) F-repairs per 100 words spoken.

[11] The distribution data for the log-transformations is presented in Table 3.10 on page 104.

Concerning the C-repair subcategories, in order of decreasing importance, speakers produced .88 (.80) Lexical Repairs, .42 (.41) Appropriacy Repairs, .22 (.39) Different Repairs and .13 (.21) Determiner Repairs per 100 words. As for the F-Repair subcategories, speakers produced, in order of decreasing importance, .34 (.44) Pronunciation Repairs, .22 (.31) Morphology Repairs and a mere .03 (.09) Syntax repairs per 100 words of discourse.

3.1.2.2.2 Description of L1 repair-type ratio data

Table 3.7 presents the distribution data for the L1 self-repair ratios according to repair type.

Table 3.7. Distribution of L1 repair-type ratio data

Repair Type	Skewness (SE) (.314)	Skewness Ratio	Kurtosis (SE) (.618)	Kurtosis Ratio
Total L1 Repairs	1.950	6.21	4.600	7.44
Total L1 C-Repairs	2.398	7.64	8.257	13.36
• Different Repairs	2.181	6.95	5.700	9.22
• Appropriacy Repairs	1.431	4.56	2.220	3.59
• Lexical Repairs	2.898	9.23	11.437	18.51
• Determiner Repairs	2.284	7.27	5.367	8.68
Total L1 F-Repairs	1.540	4.90	2.055	3.33
• Pronunciation Repairs	1.997	6.36	3.667	5.93
• Morphology Repairs	2.223	7.08	5.410	8.75
• Syntax Repairs	1.915	6.10	1.940	3.14

Note. SE = Standard Error

In line with the L2 data, the L1 repair-types were not normally distributed. The total L1 repair-ratio data reveal a moderate positive skew (z = 6.21) and a flat distribution (z = 7.44). The C-repair ratios appear to account for the large part of the flatness (z = 13.36), while the F-repair ratios approach acceptable levels (z = 3.33). Scores are also presented for each of the C- and F-repair subcategories to determine if the lack of normality could be attributed to one of those categories. Among the subcategories, lexical repairs in the C category and morphology repairs in the F category appear to be the strongest factors. In order to conduct parametric statistical tests, these data will also need to be log-transformed.

Table 3.8 presents the means and standard deviations for the L1 repair-type ratios.

Table 3.8. Means and standard deviations for L1 repair-type ratios

Repair Type	Mean	Standard Deviation	Proportion*
Total L1 Repairs	1.57	1.41	100
Total L1 C-Repairs	1.08	1.07	69
• Different Repairs	.19	.29	12
• Appropriacy Repairs	.34	.39	22
• Lexical Repairs	.47	.63	30
• Determiner Repairs	.09	.17	6
Total L1 F-Repairs	.51	.57	32
• Pronunciation Repairs	.12	.21	8
• Morphology Repairs	.34	.50	22
• Syntax Repairs	.04	.09	3

Note. * Figures are rounded to the nearest percentage.

A comparison with the brute repair data shows that the ratio proportions remain almost unchanged. Speakers ($n = 58$) produced 1.57 (1.41) repairs per 100 words. Among those repairs, 1.08 (1.07) were categorized as C-Repairs, while .51 (.57) were coded as F-Repairs. Among the C-Repairs, lexical repairs were by far the most common: speakers produced .47 (.63) such repairs per 100 words. In order of decreasing importance, speakers produced .34 (.39) Appropriacy Repairs, .19 (.29) Different Repairs and finally .09 (.17) Determiner Repairs per 100 words. Concerning the F-repairs, speakers produced mostly Morphology Repairs at rate of .34 (.50), followed by a rate of .12 (.21) Pronunciation Repairs. Syntax repairs were quite rare, with a small ratio of .04 (.09).

3.1.2.2.3 Comparison of L2 and L1 ratio data

Table 3.9 highlights the differences between L2 and L1 self-repair behavior. In order to determine which differences were statistically different, two-tailed Mann-Whitney U-tests were conducted.

Table 3.9. Comparison of L1 and L2 self-repair means

Repair Type	L1 Means	L2 Means	Percentage of Difference
Total Repairs	1.57	2.27	36%**
Total C-Repairs	1.08	1.66	42%**
• Different Repairs	0.19	0.22	15%
• Appropriacy Repairs	0.34	0.42	21%
• Lexical Repairs	0.47	0.88	61%**
• Determiner Repairs	0.09	0.13	36%
Total F-Repairs	0.51	0.6	16%
• Pronunciation Repairs	0.12	0.34	96%**
• Morphology Repairs	0.34	0.22	-43%
• Syntax Repairs	0.04	0.03	-29%

Note. * $p < .05$. ** $p < .01$.

From the table, we can see that speakers repaired 36% more in L2 than in L1. This difference was statistically significant (U(57) = 1136.00, Z = -3.01, p = .003). Most of the differences can be attributed to C-repairs, which were 42% more frequent in L2 than in L1. F-Repairs account for a more modest increase of 16% in the L2. Among the subcategories, only C-Repair differences were significant (U(57) = 1094.00, Z = -3.25, p = .001). Inspection of the C-Repair subcategories shows that the most marked difference in L2 can be attributed to a 61% increase in Lexical Repairs, followed by increases of 36% for Determiner Repairs, 21% for Appropriacy Repairs and 15% for Different Repairs. Among the C-Repairs, only differences in Lexical Repairs were significant (U(57) = 927.50, Z = -4.18, p = .000). The F-Repair categories show mixed results: Pronunciation Repairs jumped by 96% while Morphology and Syntax Repairs fell respectively by 43% and 29%. This decrease in L2 F-repairs can likely be attributed to the complexities of French morphology. Among the F-Repairs, however, only the Pronunciation Repair differences were significant ($U(57) = 1122.50$, $Z = -3.34$, $p = .001$).

The results do indeed corroborate previous research finding significant differences between L2 and L1 self-repair behavior (e.g., Bange & Kern, 1996; van Hest, 1996): Speakers self-repaired significantly more in L2 than in L1. Moreover, these differences seem to be largely driven by significant increases in Lexical and Pronunciation Repair behavior.

3.2 Attention management and self-repair behavior

Multiple regression analyses were conducted to determine whether attention-management capacity, L2 proficiency and L1 and L2 self-repair behavior interact. As a first step in the regression procedure, one must determine whether there is a moderate correlation between the variables. This correlation must not, however, be so strong (i.e., greater than $r = .70$) as to create potential issues of co-linearity (Larson-Hall, 2010, p. 190). I will thus initially present the correlation data (3.2.1), followed by the results from the multiple regression analyses (3.2.2).

3.2.1 Correlations

Before conducting parametric correlations, four assumptions must be met: The variables must be in a linear relationship; there must be independence of observation (i.e., the scores of one participant do not influence those of the others); the variables must be normally distributed; the data must be characterized by homoscedasticity (i.e., constant variance between residuals) (Larson-Hall, 2010, p. 160). Again, the self-repair data were not normally distributed, thus violating the last two assumptions. The variables were therefore transformed using a logarithm function. Table 3.10 presents the skewness and kurtosis values for the transformed data.

Table 3.10. Log transformed self-repair distribution

Repair Type	Skewness (SE) (.314)	Skewness Ratio	Kurtosis (SE) (.618)	Kurtosis Ratio
Total L1 Repairs	.212	0.68	-.507	-0.82
• L1 C-Repairs	.115	0.37	-.263	-0.43
• L1 F-Repairs	.181	0.58	-1.138	-1.84
Total L2 Repairs	.657	2.09	.380	0.61
• L2 C-Repairs	.908	2.89	.695	1.12
• L2 F-Repairs	.170	0.54	.-411	-0.67

As shown in Table 16, with the exception of L2 C-Repairs, the log-transformed data are now normally distributed. The C-Repairs maintain a slight positive skew ($z = 2.89$).

Table 3.11 presents the matrix for a two-tailed Pearson correlation including all but the L2 C-Repair variable.

Table 3.11. Correlation matrix for attention-management, proficiency and L1 and L2 self-repairs

	TMTB	Prof	L1	L1 C	L1 F	L2	L2 F
TMTB	--	-.262* (.023)	.519** (.000)	.396** (.002)	.526** (.000)	.446** (.000)	.325* (.017)
Prof		--	-.238* (.040)	-.093 (.255)	-.279* (.035)	-.229* (.044)	-.324* (.017)
L1			--	.870** (.000)	.610** (.000)	.613** (.000)	.456** (.001)
L1 C				--	.291* (.033)	.379** (.003)	.245 (.069)
L1 F					--	.468** (.001)	.456** (.003)
L2						--	.670** (.000)
L2 F							--

Note. * $p < .05$. ** $p < .01$.

The results reveal a moderate negative correlation between the attention-management (TMTB) and the proficiency measure (r = -.262, n = 58), that is, proficiency increases slightly with increases in attentional capacity scores[12]. The data also reveal a solid positive correlation between attention management and L1 (r = .519, n = 55) and L2 (r = .446, n = 57) self-repairs. Thus, as attention-

[12] When interpreting the results, it is important to keep in mind that higher TMT scores indicate lower attention-management capacity. Therefore the negative correlation between the attention and the proficiency measures should be interpreted as a positive relationship.

management capacity increases, L1 and L2 self-repair ratios decrease[13]. For L1, the formulator repairs (r = .526, *n* = 43) appear to account for the large part of this correlation with attention management. The contrary appears to be the case in L2, where the attention management/F-Repair correlation (r = .325, *n* = 43) is weaker than the overall L2 repair correlation. Proficiency reveals a low-to-moderate negative correlation with L2 self-repair behavior (r = -.229, *n* = 47). This correlation appears to be stronger with specific regard to L2 F-Repairs (r = -.324, *n* = 43), which might reflect variation in L2 formulator processes. Finally, the results also show a strong relationship between both L1 and L2 self-repairs (r = .613, *n* = 54), which likely indicates the presence of common underlying cognitive processes such as attention-management.

The correlation results indicate that the study's dependent and independent variables are indeed in a linear relationship and that no correlation is stronger than r=.70, which mitigates potential problems of multicollinearity within the data (Larson-Hall, 2010, p. 190). The data thus do not appear to violate the fundamental assumptions necessary to proceed with the following regression analyses.

3.2.2 Multiple-regression analyses

Three sets of regression analyses were conducted to probe the magnitude of the contribution of attention-management capacity in explaining self-repair behavior. To observe the role of attention-management without the presence of the other variables, I conducted an initial regression analysis with L2 self-repair ratios as the dependent

[13] When interpreting the results, it is important to keep in mind that higher TMT scores indicate lower attention-management capacity. Therefore the positive correlation between attention management and self-repair behavior should be interpreted as a negative relationship.

variable and attention-management scores as the only independent variable (3.2.2.1). To determine the magnitude of the contribution of the other variables, a hierarchical regression analysis including proficiency, attention-management and L1 self-repair behavior was conducted (3.2.2.2). A final regression was conducted to probe the predictive power of attention management on L1 self-repair behavior (3.2.2.3).

3.2.2.1 Attention and L2 self-repair behavior

The first regression analysis was conducted with L2 self-repair ratios as the dependent variable and attention-management capacity as the independent variable. Before interpreting the results, however, it is necessary to verify the fundamental assumptions, that is, the normality of the distribution of error, the homogeneity of variances, and the linearity and the absence of multicollinearity of the relationship between the variables (Larson-Hall, 2010, p. 184).

The normality of the distribution of error was verified by examining the P-P plot of standardized residuals (Appendix B.2). Inspection of the plot does not reveal significant deviation from the line, providing evidence of the normality of the distribution of error. To complete this verification, it is also necessary to identify possible outliers in the data. This was done by verifying the standard residual (min = -1.833; max = 1.969). All residual values fall between -3.0 and +3.0, which allows one to rule out the presence of outliers (Larson-Hall, 2010, p. 196). This observation was further confirmed by the verification of Cook's Distance (max = .173) and Mahalanobis Distance (max = 6.118). Cook's Distance values under 1.0 et Mahalanobis Distance values under 15 serve as indicators of the absence of outliers (Larson-Hall, 2010, p 196).

I then verified the heterogeneity of variance using a scatterplot of the studentized residuals against the predicted value of the standardized residuals (Appendix B.3). "The shape of the scatterplot should show a cloud of data scattered randomly"

(Larson-Hall, 2010, p. 196), which is indeed what was observed. The data therefore fulfill the assumption of heterogeneity of variance.

Finally, the linearity of the relationship was validated using a scatterplot of the values (Appendix B.1). In line with the correlations presented in section 3.2.1.1, this diagram reveals a positive linear relationship. To rule out the presence of multicollinearity, I confirmed the variance inflation factor (VIF; max = 1.0). The value was well under 5.0, signaling the absence of multicollinearity.

Having fulfilled the fundamental assumption required to complete the regression analysis, the results can now be interpreted. The results presented in Table 3.12 show that attention-management capacity explains about 18% of the L2 self-repair variation ($\beta = .446$, $t(1) = 3.695$, $p = .001$).

Table 3.12. Regression analysis examining the role of attention management as a predictor of L2 self-repair behavior.

Model	Total R^2	ΔR^2	TMT (β)
1	.199	.184	.446**

Note. * $p < .05$. ** $p < .01$.

3.2.2.2 Attention, L2 proficiency, L1 and L2 self-repair behavior

The other variables for which significant correlations with L2 self-repairs were observed were entered into a hierarchical regression analysis in order to determine the magnitude of their respective contribution to the L2 self-repair variance. The first regression model of this analysis included L2 proficiency; the second model included proficiency as Step 1 followed by attention-management capacity; the third model included proficiency as Step 1, attention-management as Step 2, and L1 self-repair behavior as Step 3. As has been observed in other studies investigating cognitive factors involved in L1 and L2 use (e.g., Lafrance & Gottardo, 2005), the correlation results from the previous section seem to suggest that L1 and L2 self-repair behavior are governed by the same underlying cognitive processes. Accordingly, L1 self-repair behavior would likely be the only statistically significant variable if all the variables were entered in the same step. Therefore, as in Lafrance and Gottardo (2005), a hierarchical regression was conducted in order to observe the predictive power between proficiency and attention-management and L2 repairs before the addition of L1 repair behavior in Model 3.

Several measures were taken to ensure that the additional data respect the assumptions related to regression analyses. Scatterplots crossing the independent variables proficiency (Appendix B.4) and L1 self-repair (Appendix B.5) with L2 self-repairs revealed a linearity that was in line with the correlations presented in 3.2.1.1. A P-P plot of standard residuals (Appendix B.6) indicates a normal distribution of error. Verification of the standard residuals (min = -2.321; max = 1.927) assures the absence of outliers, which was confirmed by Cook's Distance (max = .108) and Mahalanobis Distance (max = 9.051). A scatterplot crossing studentized residuals against the predicted value of the standardized residuals (Appendix B.7) assures the heterogeneity of variance. Finally, multicollinearity was ruled out by a variance inflation factor (VIF; max = 1.057) well under 5.0. With these assumptions respected, I present the results of the regression. Table 3.13 presents those results.

Table 3.13. Hierarchical regression analyses examining the predictors of L2 self-repair behavior

Model	Total R^2	ΔR^2	Proficiency (β)	Attention (β)	L1 Repairs (β)
1	.227	.052	-.227		
2	.463	.215	-.121	.417**	
3	.635	.404	.002	.167	.511**

Note. * $p < .05$. ** $p < .01$.

The analyses indicated that the three predictors explained 40% of the variance ($R^2 = .40$, $F(3,50) = 11,27$, $p < .001$). The results show that the predictive power of L2 proficiency in Model 1 approaches significance ($\beta = -.227$, $t\ (1) = -1.68$, $p = .09$). It only explains, however, about 5% of the variation. This significance disappears in Model 2, where only attention-management capacity is significantly related to L2 self-repair behavior ($\beta = .417$, $t\ (2) = -3.25$, $p = .002$), explaining an additional 16% of the variation. Finally, as predicted, in Model 3 only L1 self-repair behavior is significantly related to L2 self-repair behavior ($\beta = .511$, $t\ (3) = 3.98$, $p = .000$), itself contributing an additional 19% to the explanatory power of the model. Again, given that our correlation analyses indicate strong positive relationships between attention management and both L1 and L2 self-repairs, it is likely that attention management is confounded in the L1 self-repair variable[14]. To probe this claim further, I specifically examined the link between attention management and L1 self-repair behavior. Those analyses are presented in the next subsection.

3.2.2.2.1 Attention and L1 self-repair behavior

To test the relationship between attention management and L1 self-repairs, I conducted a regression analysis with L1 self-repairs as the dependent variable and

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[14] To verify the extent of the predictive power between attention management and L1 and L2 self-repairs, a stepwise regression analysis was conducted with L2 self-repairs as the dependent variable and attention-management capacity, L1-self-repairs and a new variable combining attention-management and L1 self-repairs as independent variables. The resulting Model explains 41% of the variance ($R^2 = .41$, $F(3,50) = 36,13$, $p < .001$). However, only the combined variable ($\beta = .640$, $t\,(1) = -6.01$, $p = .000$) was a significant predictor of L2 self-repairs, that is, both attention-management and L1 repair-behavior were excluded from the analyses when the combined variable was added to the model.

attention-management capacity as the independent variable. Assumptions were verified with a P-P plot of standard residuals (Appendix B.8) indicating a normal distribution of error. The standard residuals (min = -2.321; max = 1.927), Cook's Distance (max = .155) and Mahalanobis Distance (max = 6.021) assured the absence of outliers. The heterogeneity of variance was validated by a scatterplot crossing studentized residuals against the predicted value of the standardized residuals (Appendix B.10). Finally, a scatterplot of values (Appendix B.8) reveals a relatively strong linear relationship without the presence of multicollinearity (VIF; max = 1.0). The results of the regression analysis are presented in Table 3.14.

Table 3.14. Regression analysis examining the role of attention-management as a predictor of L1 self-repair behavior

Model	Total R^2	ΔR^2	TMT (β)
1	.270	.256	.519

Indeed, the results show that attention-management capacity explains 26% of the L1 self-repair variation (β = .519, t (1) = -4,422, p = .000). These results suggest that the relationship between attention shifting and self-repairs is stronger in L1 than L2. The robust relationship between attention and both L2 and L1 self-repair behavior suggests that part of L1 self-repair behavior's contribution to L2 self-repair behavior is attention management capacity.

To summarize, attention-management capacity appears to play a significant role in L2 speech production. When examined in the absence of the proficiency and L1 self-repair variables, attention explained 18% of the variance. When inspecting the role of the other explanatory variables, proficiency appeared to contribute about 5% to the predictive power of the model, however this figure only approached significance. Attention management contributed an additional 16%[15] to the L2 self-repair variation. Finally, the addition of L1 self-repairs contributed an increase of 19% to the explanatory power to the model. All models confounded, the variables explained 40% of the variation. It was suggested that part of L1 repair behavior's contribution could be, in effect, attributed to attention management. To test this claim, the relationship between attention-management and L1 self-repairs was examined, which revealed that the attention-repair link, explaining 26% of the variation, was even stronger in L1 than in L2. It appears that the L1 self-repair variable and the attention-management variables overlap.

3.3 Low and high attention-management group differences

The results presented in the previous section revealed a significant relationship between attention-management capacity and L1 and L2 self-repair behavior. In this section, I aim to create a more fine-grained portrait of the relationship between attention-management and self-repairs by comparing the distribution of the self-repair types produced by a high attention-management and a low attention-management group. The groups were created using the top (n = 20) and the bottom (n = 20) third of the TMTB scores of the study population (n = 58). I will first present the means and standard deviations, as well as between-group differences, for both groups with regard to proficiency and attention-management (3.3.1), followed by the means and standard deviations and between-group differences for self-repair behavior in both L2 (3.3.2) and L1 (3.3.3). In order to determine which differences were statistically

[15] This figure is the R Square change after the R Square contributions of proficiency.

significant, Mann-Whitney U-tests were conducted. I conclude this section with a synthesis of the results (3.3.4)

3.3.1 Attention and L2 proficiency for low and high groups

Table 3.15 presents the means and standard deviations for the L2 proficiency and attention-management scores of the high-attention and low-attention groups. The table also includes high-low between group differences.

Table 3.15. Means and standard deviations for attention-management and L2 proficiency according to high and low attention-management capacity groups

Tests	High Attention Means (SD)	Low Attention Means (SD)	Percentage of Difference	U-Score
Attention Management (*Trail Making Test B*)	285.85 (34.71)	486.65 (62.12)	52%	.000**
L2 Proficiency (*The cloze procedure*)	59.3 (17.54)	57.3 (15.73)	-3%	176.5

Note. **p* < .05. ** *p* < .01.

First, I needed to insure that the proficiency variable was not confounded with the attention-management variable with respect to the two groups. Indeed, high-attention speakers scored only 3% higher than the low-attention group. The Mann-Whitney U-test showed that this difference was not statistically significant. The mean attention-management score (TMTB), however, was 285.85 (34.71) for the high attention group and 486.65[16] (62,12) for the low attention group, constituting a 52% difference, which was statistically significant (U(19) = .00, Z = -5.41, p = .000).

[16] Let us recall that as the TMT score increases attentional capacity decreases.

3.3.2 L2 self-repair behavior for low and high groups

We now turn to the characteristics of L2 self-repair behavior for both the high and low attention groups. Table 3.16 presents the ratio data for both groups according to repair types. Once again, one-tailed Mann-Whitney U-tests were conducted to determine which repair-type differences were statistically different.

Table 3.16. Means and standard deviations for L2 repair types according to high and low attention-management groups

Repair Type	High Attention Means *(SE)*	Low Attention Means *(SE)*	Percentage of Difference	U-Score
L2 Repairs	1.69 *(1.03)*	3.38 *(2.38)*	67%	104.00**
L2 C-Repairs	1.21 *(.72)*	2.46 *(1.99)*	68%	104.50**
• Different	0.08 *(.17)*	0.41 *(.51)*	134%	108.00**
• Appropriacy	0.22 *(.26)*	0.71 *(.49)*	105%	64.50**
• Lexical	0.82 *(.51)*	1.14 *(1.17)*	32%	199.50
• Determiner	0.09 *(.14)*	0.22 *(.29)*	86%	154.00
L2 F-Repairs	0.48 *(.46)*	0.92 *(.87)*	64%	138.00*
• Pronunciation	0.21 *(.25)*	0.52 *(.58)*	84%	139.50*
• Morphology	0.22 *(.29)*	0.38 *(.37)*	53%	149.00
• Syntax	0.04 *(.10)*	0.02 *(.09)*	-67%	181.50

Note. $^{*}p < .05$. $^{**}p < .01$.

The low-attention group repaired 67% more frequently than the high-attention group: The high group produced a mere 1.69 (1.03) repairs per 100 words, while the low group produced 3.38 (2.38). This difference was statistically significant ($U(19) = 104.00$, $Z = -2.58$, $p = .005$). The results also show that differences for C-Repairs and F-Repairs were very similar. Low attention speakers produced 68% more C-Repairs and 64% more F-Repairs than high attention speakers. These C-Repair ($U(19) = 104.5$, $Z = -2.58$, $p = .005$) and F-Repair ($U(19) = 138.00$, $Z = -1.69$, $p = .05$) differences were statistically significant.

Among the C-Repair subcategories, the higher discourse-level repairs, that is, Different (134%) and Appropriacy (105%) repairs, accounted for the strongest differences for high- and low-attention speakers. The differences between the two groups for both Different Repairs ($U(19) = 108$, $Z = -2.76$, $p = .006$) and Appropriacy Repairs ($U(19) = 64.5$, $Z = -3.7$, $p = .000$) were statistically significant. This finding suggests that attention-management capacity facilitates pre-articulatory conceptual processing, therefore, resulting in fewer post-articulatory repairs. Determiner repairs accounted for the next most important difference, with an increase of 86% for low-attention speakers. Let us recall that Determiner Repairs involve only changes between definite and indefinite repairs, making these repairs more akin to Different and Appropriacy Repairs than Lexical Repairs. Finally, Lexical Repairs represent the smallest differences (38%) between high- and low-attention speakers. Not surprisingly, a Mann-Whitney U-test revealed that these two differences were not statistically significant.

Inspection of the F-Repair subcategories reveals that the strongest difference lies within the Pronunciation Repairs, of which low-attention speakers produced 84% more than high-attention speakers. Moreover, Pronunciation Repairs constituted the only difference in the F-Repair subcategory that was significant ($U(19) = 139.5$, $Z = -1.69$, $p = .05$). About Morphology, low-attention speakers made 53% more such repairs than the high group. Finally, Syntax Repairs composed the only repair type that was produced more frequently by high-attention speakers. Indeed, they made 67% more Syntax Repairs than the low group. However, as mentioned above, neither morphology nor syntax differences were significant, which could be a result of the very infrequent occurrences of these repair types in the corpus.

3.3.3 L1 self-repair behavior for low and high groups

To complete the portrait of the role of attention management in self-repair behavior, I present here the L1 data for the high- and low-group differences. The figures presented in Table 3.17 show that low-attention speakers make 79% more repairs in L1 production than high-attention speakers.

Table 3.17. Means and standard deviations for L1 repair types according to high and low attention-management groups

Repair Type	High Attention Means (SE)	Low Attention Means (SE)	Percentage of Difference	U-Score
L1 Repairs	1.07 (.70)	2.46 (1.96)	79%	111.00**
L1 C-Repairs	0.75 (.58)	1.63 (1.52)	74%	126.00*
• Different	0.10 (.20)	0.27 (.41)	93%	150.00
• Appropriacy	0.30 (.36)	0.44 (.49)	40%	165.50
• Lexical	0.28 (.25)	0.79 (.91)	97%	138.00*
• Determiner	0.09 (.18)	0.12 (.21)	25%	189.00
L1 F-Repairs	0.35 (.28)	0.83 (.75)	81%	136.00*
• Pronunciation	0.11 (.16)	0.20 (.27)	62%	174.00
• Morphology	0.19 (.24)	0.58 (.70)	102%	136.00*
• Syntax	0.05 (.11)	0.06 (.10)	8%	197.00

Note. *$p < .05$. ** $p < .01$.

High-attention speakers made 1.07 (.70) repairs per 100 words while low-attention speakers made 2.46 (1.96) repairs per 100 words. A Mann-Whitney test revealed this difference to be statistically significant (U(19) = 111, Z = -2.4, p = .007). Contrary to the L2 differences, low-attention speakers appear to have slightly more difficulty at the formulator-level of production than at the conceptual-level. This is illustrated by an 81% increase in F-Repairs in contrast with a 74% in C-Repairs for low-attention speakers. Both the F-Repair (U(19) = 136, Z = -1.73, p = .041) and the C-Repair (U(19) = 126, Z = -2.01, p = .023) differences were statistically significant.

Concerning the F-Repair subcategories, low-attention speakers targeted Morphology in particular, with an increase of 102% compared to high-attention speakers. This was the only F-repair subcategory for which the difference was significant (U(19) = 136, Z = -1.8, p = .043). Such a pronounced difference might be attributed to greater difficulty among low-attention speakers in activating complex French morphological structures before articulation. Following Morphology Repairs, Pronunciation Repairs accounted for a large, but more modest, difference of 62%, while observation of Syntax Repairs revealed a relatively slight difference of only 8%. Neither of the differences for these subcategories was significant.

The dominating low- and high-attention differences among the C-Repair subcategories were Lexical and Different Repairs, with low-attention speakers making 97% and 93% more repairs respectively. The low-attention speakers also made 40% more Appropriacy Repairs and 25% more Determiner Repairs. However, among the differences for these subcategories, only Lexical Repairs were statistically significant (U(19) = 138, Z = -1.69, p = .05).

3.3.4 Synthesis of the results for group differences

First, the results from the non-parametric Mann-Whitney U-tests using the study's untransformed ratio data presented in this section corresponded to, and therefore bolstered, those of the parametric linear regression results based on the log-transformed data presented in the previous section. The low and high-attention groups indeed behaved significantly differently with respect to self-repair behavior in both L1 and L2. The differences were more pronounced in L1 than in L2: Low-attention speakers repaired 67% more in L2 and 79% more in L1 than high-attention speakers. Inspection of repair-types revealed that repair increases in L2 for low-attention speakers were roughly evenly divided between C- and F-Repairs. However, C-Repairs (68%), in contrast to F-Repairs (64%), were more pronounced in L2, while F-Repairs (85%) were more important than C-Repairs (74%) in L1. Among the C-Repairs, low-attention appeared to generate more A- (134%) and D-Repairs (135%) in the L2 and more Lexical Repairs in the L1 (97%). This suggests that low attention increases difficulty in arranging upper-level discourse features before articulation, which leads to an increase in post-articulation A- and D-repairs. In L1, low attention seems to lead to a more pronounced increase in local lexical repairs. Finally, in L2 low-attention appeared to have the greatest influence on Pronunciation Repairs (84%), while in L1, the strongest influence was on Morphology Repairs (102%), which could reflect specific characteristics of the French language.

CHAPTER IV

DISCUSSION

The objective of the present study was to determine whether attention-management capacity is linked to L2 self-repair behavior, and, if so, whether the attention-L2 self-repair relationship is mediated by L2 proficiency and L1 self-repair behavior. To find an answer to this question, 58 university-level native French speakers of English as a second language of various proficiency levels were recruited. The data were collected in a laboratory setting wherein participants completed four tasks: a cloze procedure to measure L2 proficiency, the TMT test to gain an attention-management score, a picture-cued narration task in both French L1 and English L2. Socio-demographic information was also collected though a participant questionnaire. The L1 and L2 narrations were transcribed and the repair data were isolated and coded by two judges. Correlation and regression analyses allowed me to create a portrait of the relationship between the variables. Complementary analyses using the Mann Whitney U-test were also conducted to examine high- and low-attention group differences. In this section, I will interpret the results presented in the previous chapter in order to answer each of the research questions formulated at the outset of the study. This will permit me to determine whether the results allow me to confirm or reject the ensuing hypotheses (4.1). For each research question I will present the relevant statistical results, followed by an analysis and interpretation of the results with regard to previous studies. I will conclude this chapter with a discussion of various directions for future research (4.2)

4.1 Discussion of the results

Let us recall that the model of attention proposed for the study was derived from multiple-resource models based on attention for action. Attention was therefore conceived of as drawing simultaneously on multiple-resources, which, depending on levels of automaticity, operate in a selective manner wherein decrements in performance are the result of interference originating from inefficiencies in coordinating multiple-resource use rather than capacity limitations. As speech production requires the coordinated distribution of such resources across multiple, parallel conceptualization and formulation processes, one would expect a link between the efficiency of those processes and attention-management capacity.

I argued that the best way to examine attention allocation during speech production was through the observation of self-repairs, which were defined as "revisions of speech that the speakers themselves had initiated and completed" (p. 859). According to the model representing the relationship between attention and speech production that I proposed for the present study, attention-management is linked to self-repair behavior in the following way: greater attention-management capacity results in faster and more efficient pre-articulatory language processing on both the conceptualization and formulation levels; the monitoring processes therefore detect fewer mismatches between production and speakers' intentions, which results in fewer self-repairs. Figure 4.1 offers an illustration of the model.

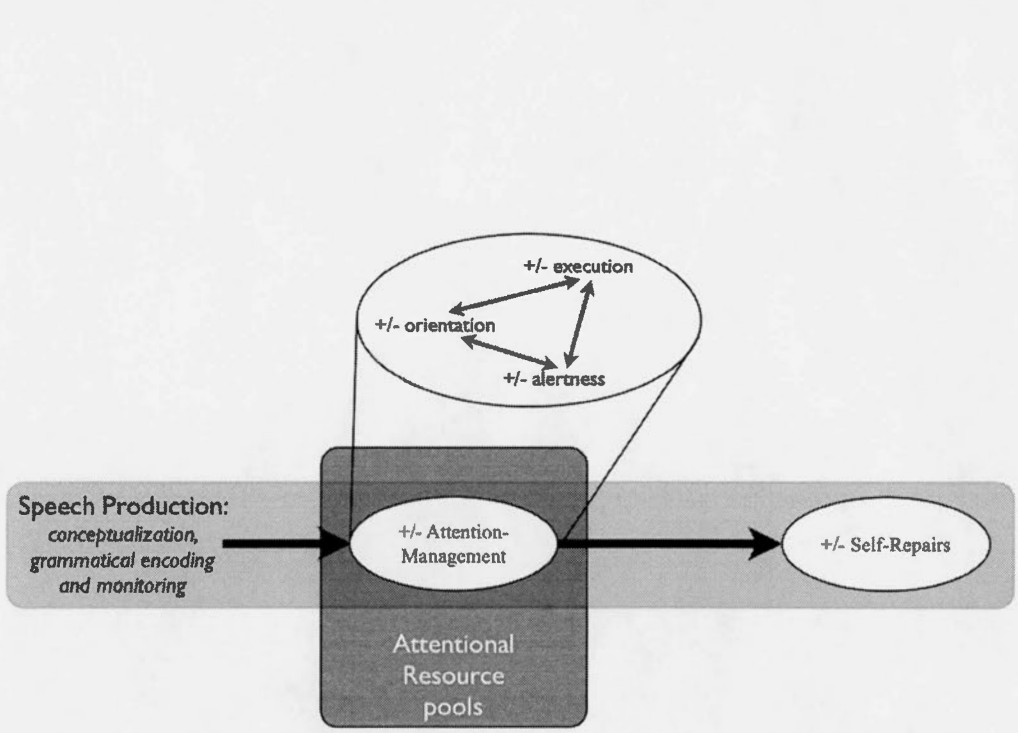


Figure 4.1. The model representing the relationship between attention and speech production used for the present study

Let us recall that I hypothesized that during speech production, conceptualization, grammatical encoding and monitoring processes pass within perceptual range of the attentional resource pools. Automatized processes pass through, demanding little or no attentional resources, while unautomatized processes draw on the multiple attentional resource pools to varying degrees. The efficiency with which such resources are allocated depends on attention management, which itself varies as a function of the efficiency of the interplay between the three attentional networks, that is, alertness, orientation and execution. As attention-management decreases, decrements in performance outcomes increase resulting in an increase of self-repairs.

The discussion in this section will turn around two themes: I will start by addressing assertions that the results allow us to make apropos of attention-management and L2 self-repair behavior (4.1.1). The secondary variables, proficiency and L1 self-repair behavior, will then be discussed in light of their interaction with attention-management capacity and L2 self-repair behavior (4.1.2). I will discuss each of these themes through the lens of the results obtained from the regression analyses as well as those obtained from the high- and low-attention group comparisons, and this, in relation to findings from previous speaker-centered speech production research.

4.1.1 Question one: Attention management and L2 self-repair behavior

From the theoretical framework presented in Chapter 2 on the role of attention in speech production, I formulated the following research question: Is there a relationship between attention management capacity and self-repair behavior in L2 speech production? To answer this question the following hypothesis was stated: *Participants with low attention-management capacity will produce more self-repairs than participants with higher attention-management capacity*. The results presented in this chapter allow me to confirm this hypothesis.

Pearson's correlations were conducted to determine the presence of interaction between L2 self-repair behavior and attention-management capacity, which revealed a significant relationship between the TMTB and the total L2 Repair ratios ($r = .446$, $n = 57$). Among the subcategories, a modest relationship was also found between the TMTB and L2 F-Repairs ($r = .324$, $n = 43$). Recall that the L2 C-Repairs were not normally distributed and thus not included in the correlation matrix. To determine the magnitude of this relationship, a linear regression analysis was conducted with L2 Self-Repairs as the dependent variable and attention-management as the independent variable. The results show that indeed attention-management capacity explains 18% of the L2 self-repair variation ($\beta = .446$, $t\,(1) = 3.695$, $p = .001$).

To gain a more nuanced picture of this relationship, L2 self-repair behavior was observed in a low-attention and a high-attention group. Indeed, the low attention-management group repaired 67% more than the high group ($U(19) = 104.00$, $Z = -2.58$, $p = .005$). Attention-management seemed to effect both C- and F-Repairs in a similar manner, as low attention speakers produced 68% more C-Repairs

(U(19) = 104.5, Z = -2.58, p = .005) and 64% more F-Repairs (U(19) = 138.00, Z = -1.69, p = .05) than high attention speakers. Different Repairs (U(19) = 108, Z = -2.76, p = .006) and Appropriacy Repairs (U(19) = 64.5, Z = -3.7, p = .000) constituted the most significant differences among C-Repairs, suggesting that attention-management capacity helps speakers better plan and execute discourse level features before articulation, which results in fewer of such repairs. This finding underscores the notion that the conceptualizer is a great consumer of attentional resources. Among F-Repairs, attention-management capacity appeared to have the greatest effect on Pronunciation Repairs, with an 84% increase for low-attention speakers (U(19) = 139.5, Z = -1.69, p = .05).

It might seem like a curious finding that the strongest interaction between attention and speech production process occurs within the two levels of processing occupying opposite ends of the attention demand continuum: It interacts most with conceptual level planning, which is often considered the most attention-demanding level of processing, and pronunciation, which, on the contrary, is often regarded as the most automatized and least demanding of resources. However, let us recall that, according to the Levelt model, articulation is the most complex process, involving the coordination of about 100 muscles spread across three organs. For L1 speakers this process is fully automatic. If it were not so automatized, fluent L1 speech would be impossible. For L2 speakers, for whom these processes are not yet automatized, articulation can be an extremely taxing process. It therefore makes sense that pronunciation would correlate with attention-management capacity.

The study's results show that participants with low attention-management capacity produce more self-repairs than participants with high attention-management capacity. This attention-management effect seems to be most pronounced with conceptualizer repairs in general and pronunciation repairs of the formulator. This finding is in line with the research proposals presented in Simard *et al.*, (2011), in which the authors argue that an investigation of processual aspects of attention would help better understand its role in self-repairs.

4.1.1.1 Discussion of question one in light of previous research

The only two studies to have broached questions concerning attention and L2 speech production through the observation of self-repair behavior are Fincher (2006) and Simard *et al.* (2011). Fincher (2006) examined links between the self-repair behavior exhibited during 7 hours of classroom interaction and the results from a questionnaire designed to measure participants' perception of their attentional capacity. Similarly, Simard *et al.* (2011) investigated potential relationships between the self-repair behavior of 23 intermediate French L2 learners and a psychometric measure of their attentional capacity. Neither study was able to establish a significant link between the two factors.

Contrary to Fincher (2006) and Simard *et al.* (2011), the present study establishes a significant link between variation in attention-management capacity and self-repair behavior among French L1 English L2 speakers of various proficiency levels. Indeed, linear regression analyses suggested that variation in attention-management capacity accounts for nearly 20% of the variation L2 self-repair behavior. These results were bolstered by the low- and high-attention group comparisons, which showed that low-attention speakers produce 67% more self-repairs in general. These results clearly suggest that attention plays a determinate role in L2 speech production observed through self-repair behavior.

How can such robust results be reconciled with the non-significance or the tepid trends toward significance observed in previous research? The answer to this question points to key methodological differences with specific regard to, on the one hand, the measurement instruments used to gather attention and self-repair data, and, on the other hand, the population and speech sample sizes.

It has been suggested that attentional capacity influences speakers' capacity to self-repair (Kormos, 1999a). Such claims have in part been a motivating force behind the research investigating attention and self-repairs. Fincher (2006) used a questionnaire designed to measure participants' perception of their attention resources through a series of 20 multiple-choice questions targeting work-place demeanor. I argue that a perception-based test cannot be used as an accurate measure of individuals' actual attentional capacity. Fincher (2006) did complement this measure with one that could be deemed psychometric: It was a test completed online during which participants were evaluated according to the speed with which they could click on a given shape according to instructions. The results assigned participants to one of five levels ranging from low to high. Given that four of the five participants were assigned to level 5 (High) and the remaining participant to level 4 (Above Average), the test did not detect variation in attentional capacity among her participants. Furthermore, the study's small sample size made it impossible to conduct any inferential statistical tests.

Simard *et al.* (2011) aimed to address both the issue of test validity and sample size by employing a validated psychometric test used to gain measures of attentional capacity (d2 Test of Attention) with 23 French L2 participants. This test measures participants vigilance in detecting occurrences of the letter "d" accompanied by two diacritic marks embedded in 14 lines of 47 occurrences of the letter "d" with anywhere from one to four marks. This test measures participants' capacity to remain vigilant across time in order to detect a target stimulus, which harkens back to the radar surveillance tests typical of early attention research. While the researchers did succeed in obtaining a normal distribution of attention results, they found no link between the results and the self-repair behavior of their participants. In fact, they suggest in their discussion that they were likely targeting the wrong aspect of attention and propose future research investigating a processual aspect of attention, which would be manifested in individuals' capacity to shift attention between multiple simultaneous tasks (Simard, *et al.*, 2011, p. 15). Indeed such a representation is more in line with the Levelt's model, which depicts speech production as an attention-management task. The instrument selected for the present study, the Trail Making Test, provided a validated measure of such a processual aspect of attention, and allowed me to establish a link between attention and L2 speech production, confirming my hypothesis from the outset as well as the argument made by Simard *et al.* (2011).

Another factor that may explain these differences is related to the participant and the speech production sample sizes. While the seven hours of recorded classroom dialogue offered Fincher's (2006) a rich set of self-repair data, the sample of 5 participants was far too small to obtain enough attention data to perform inferential statistics. Although Simard *et al.* (2011) had a larger sample size (n=23), the two minutes of dialogue from which the repair data were extracted might have been too small to obtain a sufficient number repair occurrences to achieve enough statistical power for significant results. This is a problem that emerged in the unpublished pilot study conducted in preparation for this dissertation: The same methodological procedures were used, except there were only 23 participants and speech samples of only two minutes were collected. In the pilot study data, significant correlations were observed, but the statistical power of those results was far too weak to make any claims (Zuniga & Simard, 2011).

In sum, the differences between the findings from the present study and those from Fincher (2006) and Simard *et al.* (2011) can likely be attributed to methodological differences concerning the validity of the measurement instruments used to gather attention data, the participant sample sizes, and the size of the speech samples used to collect repair data.

4.1.2 Question two: Proficiency and L1 self-repair behavior

The second research question was the following: If there is a relationship between attention management capacity and self-repair behavior, is it mediated by L2 proficiency, and L1 self-repair behavior? In order to find an answer to this research question, I formulated the following hypothesis: *Attention-management capacity and self-repairs are mediated by participants' L2 proficiency and L1 self-repair behavior.* The results allow me to partially confirm this second hypothesis.

Pearson correlations revealed a weak negative relationship between L2 self-repair ratios and L2 proficiency ($r = -.229$, $n = 47$), that is, as proficiency increases, speakers tend to make slightly fewer self-repairs. There was, however, a strong positive correlation between L2 and L1 self-repair ratios ($r = .613$, $n = 54$), revealing that frequent repairers behave similarly in both their native and second languages. These correlations suggest that there is a relationship but do not say much about its magnitude. Hierarchical regression analyses showed that proficiency, approaching significance, explains about 5% of the L2 self-repair variation ($\beta = -.227$, $t(1) = -1.68$, $p = .09$) before the other variables were entered into the subsequent models. The attention-management variable contributed an additional 16% to the explanatory power of Model 2 ($\beta = .417$, $t(2) = -3.25$, $p = .002$), but the proficiency variable moved further away from significance. Finally, L1 self-repair behavior added 19% of predictive power in Model 3 ($\beta = .511$, $t(3) = 3.98$, $p = .000$), but both proficiency and attention-management lost their significance.

I argued that the strong relationship between the L2 and L1 self-repair variables was partially governed by common underlying cognitive traits, such as attention management. A regression analysis adding the combined attention-management and L1 self-repair variables was conducted, with the resulting Model explaining 41% of the variance (R^2=.41, F(3,50)=36,13, p<.001). Indeed, only the combined variable ($\beta = .640$, $t(1) = -6.01$, $p = .000$) was a significant predictor of L2 self-repairs.

Finally, a multiple regression analysis testing the relationship between attention-management capacity and L1 self-repairs, revealed a model explaining 26% of the L1 self-repair variation (β = .519, t (1) = -4,422, p = .000). The strength of this relationship suggests an overlap between the attention-management variable and the L1 self-repair variable. It also suggests, however, the presence of other individual difference variables governing both L1 and L2 self-repair behavior not considered in the present study. These results partially confirm hypothesis two, in that L1 self-repair behavior meditates the relationship between L2 self-repairs and attention-management. The relationship between L2 proficiency and L2 self-repairs can, in the present study, only be classified as a trend.

4.1.2.1 Discussion of question two in light of previous research

Several studies in the domain of speaker-centered self-repair research have also examined the interaction between proficiency (e.g., Kormos, 2000a; Kormos, 2000b O'Connor, 1988; Verhoeven, 1989), L1 self-repair behavior and L2 self-repair behavior (e.g., Bange & Kern, 1996; van Hest, 1996). However, to the best of my knowledge, no studies have done so while accounting for the attention variable. Moreover, the objectives of the L1-L2 studies (e.g., Bange & Kern, 1996; van Hest, 1996) focused on contrasting L1 and L2 repair behavior without investigating causal links between the two. A direct comparison of my results with those of previous research is therefore not possible. Accordingly, for the L2 proficiency variable, my discussion with turn around a comparison of the role of proficiency without specific regard to attention management. This will permit me to determine if my corpus is in line with those of previous proficiency studies. Similarly, the first part of the discussion of the L1-L2 relationship will focus on behavioral differences observed through repair-type frequency and distribution data without consideration of the attention variable. Again, this will allow me to determine if my corpus is comparable to those of the previous studies. Finally, to integrate the notion of attention management into the discussion, I will turn to research examining relationships between L1 and L2 fluency (Derwing *et al.*, 2009). My study is comparable to Derwing *et al.* (2009) in that they both attribute the relationship between an aspect of L1 and L2 speech production to a common underlying cognitive trait.

The influence of proficiency on self-repair behavior has indeed been well-documented, revealing that behavior changes in tandem with increases in proficiency. Aside from O'Connor (1988), who found a greater frequency of repairs among lower proficiency participants, most studies (e.g., Kormos, 2000a; Kormos, 2000b; van Hest, 1996; Verhoeven, 1989) have shown that as proficiency increases the number of self-repairs remains relatively stable, but the targets of the self-repairs move from lower-level local form repairs to conceptual level repairs. That is to say, as speakers' L2 proficiency increases, the nature of their repair behavior trends toward that of native speakers. Inspection of the correlation results from the present study shows that my data appear to be in line with these findings. There was a small significant negative correlation between proficiency and total L2 Repairs ($r=-.229$), that is, speakers made fewer self-repairs as proficiency increased. Furthermore, Model 1 of the hierarchical regression analysis revealed that proficiency did indeed account for 5% of the variance before the attention measures and L1 behavior were entered into the model, at which point proficiency lost significance. Concerning shifts in repair types, a look at the correlation matrix shows a stronger significant negative correlation for the F-Repairs ($r=-.344$) than for the total repairs. This indicates that the large part of the total repair decrease can be accounted for by an even greater decrease in F-Repairs, signaling a shift toward conceptual level repairs as proficiency increases. It is important to note that I must infer this claim because, since the log-transformed C-Repair data were still not normally distributed, I could not enter that variable into the correlation matrix. In sum, the results signal a tendency toward a slight reduction in repair frequency and movement from form to conceptualizer repairs as proficiency increases. These findings are clearly line with those of other speaker-centered studies examining the question of proficiency.

Turning to the L1 self-repair variable, as a direct comparison of our results to those of previous research is not possible, I will first discuss my findings in light of studies targeting qualitative and quantitative comparisons of L1 and L2 self-repair behavior, before moving the discussion to research whose authors argue that L1 and L2 fluency characteristics are governed by common underlying cognitive factors.

With regard to the comparison of L1 and L2 self-repair frequency, the present study revealed that speakers made 17% more repairs in L2 than in L1. This resembles the 26% increase that van Hest (1996) found in her Dutch participants' English L2 production, but is considerable less than the 400% increase that Bange and Kern (1996) found among their German L2 participants when compared to the French L1 participants. However, while the vast L1-L2 differences published in Bange and Kern are not comparable to the aforementioned studies since the data were not generated by the same participants in L1 and L2 — as was the case in van Hest (1996) and the present study —, one trend appears undeniable; that is, speakers repair significantly more frequently in their second language. Again, I attribute this L2 increase in repairs to the resource-demanding, unautomatized formulator processes typical of L2 production.

The other principal theme that arises in the L1-L2 studies is that of repair-type distribution differences. van Hest (1996) found superior proportions of conceptual repairs in their L1 data. Their participants made 15% more A-Repairs and 56% more D-Repairs of the proportion of total repairs in L1 than in L2. Bange and Kern (1996) found a similar trend, that is, the proportion of A-repairs was nearly double and the proportion of D-Repairs increased by about 700% in L1. The results from the present study were similar in that L1 made more conceptual level repairs: 21% more A-Repairs and 15% more D-Repairs. The participants of the present study largely behaved in a way similar to those of other repair distribution inquiries, with the exception of morphological F-Repairs (see examples in the following paragraph).

Data for repairs that I coded as targeting morphology diverged from the work of Bange and Kern (1996) and van Hest (1996). I observed 43% more morphology repairs in L1 than L2, while Bange and Kern (1996) did not observe a single morphology repair in L1 (22 observations in L2) and van Hest (1996) observed equal occurrences between L1 and L2. A clear explanation for the wide variation of results found between these three studies points to the characteristics of the varying surface features of languages. Remember, unlike the conceptualizer, the formulator is language specific and variation is expected to occur in tandem with variation in the specific morphophonological features of a given language. I would argue that the rich morphology and the elision phenomenon that is characteristic of the French language resulted in a high frequency of what I coded as morphology repairs in L1. The following offers an example: /le… lezotRmɛzɔ̃/. The speaker intends to say "Les autres maisons" (The other houses). However, she utters the definite plural determiner les /le/, without realizing the elision /z/ which occurs when this determiner is followed by an attack headed by a vowel, and then interrupts the utterance to execute the correction. As a result of this phenomenon, I observed a greater proportion of F-Repair in my data than that which has been observed in previous studies. Aside from this divergence, the distributional findings from the present study are nonetheless along the same lines as those from van Hest and Bange and Kern. Viewing the data from this angle does not, however, get to the heart of the issue addressed in this section, which concerns how L1 self-repair behavior interacts with that of the L2 with regard to attention-management capacity. For this, I turn to an L1-L2 fluency study.

Derwing *et al.* (2009) aimed to investigate the relationship between L1 and L2 fluency ratings over time. They observed a positive correlation between the Mandarin

L1 and English L2 speakers' fluency rates (r=.527) and an even stronger correlation for the L1-L2 production of Russian speakers of English as a second language (r=.620). While this correlation diminishes over time, suggesting that the trait behind L1 fluency is particularly powerful in the early stages of acquisition but drops as proficiency increases, the authors argue that L1 and L2 production are governed by the same underlying cognitive features; one of which they claim is working memory. Citing such findings upon justification for my second hypothesis, I expected attention-management capacity to influence L1 and L2 repair behavior in the same way. The robust significant correlation I found between L1 and L2 repair behavior (r=.613) corroborates Derwing *et al.*'s (2009) findings. Is this relationship, however, influenced by attention-management capacity?

To examine L2 self-repair links between attention management, L1 self-repair behavior and L2 proficiency, I conducted a hierarchical multiple regression analyses in order to observe the interaction between proficiency and attention-management and L2 repairs before the addition of L1 repair behavior in Model 3. Recall that the first model revealed that proficiency accounted for 5% of the L2 self-repair variance. The significance of this relationship was erased when the attention variable was added, contributing and additional 15% of explanatory power to the model. Finally, both attention and L2 proficiency were relegated to insignificance when the L1 self-repair variable added an additional 20%. Model 3 indeed accounted for 40% of the L2 self-repair variance. The results from these analyses leave little doubt that both L1 self-repair behavior and attention play a decisive role in defining L2 self-repair behavior, but why would the addition of L1 self-repairs to the model erase attention's contribution? I would argue that a measure of L1 self-repair behavior is also a measure of attention-management capacity.

Let us remember that the regression analyses showed that attention-management capacity accounted for 26% of the L1 variance and 18% of the L2 variance. Furthermore, the group comparisons also showed a stronger influence for attention in

L1 production. The low-attention group repaired 79% more than then high-attention group in L1 and 67% more than the high-attention group in L2. This constitutes a 13 percentage-point difference. The observation of a stronger relationship between attention and L1 self-repair is an interesting finding. If one considers that L2 speech is characterized by cognitively demanding controlled processing, which pushes many speakers to the limits of their capacities, one might reasonable expect to find a greater relationship between attention and L2 repairs. These findings, however, call for an alternate explanation. I argue, on the contrary, that the absence of the influence of proficiency related variables in L1 allows for the observation of the interaction between innate cognitive variables, such as attention-management, and speech production without interference. In other words, attention-management is an underlying factor involved in both L1 and L2 self-repair behavior, but the L1-attention link is expressed more strongly in the absence of the mitigating L2 proficiency variables.

In summary, with respect to repair frequency and distribution, the data from the present study is line with that of previous studies. Speakers repair more frequently in L2, and as L2 proficiency increases, there is a minor reduction in the frequency of repairs and a trend toward a higher proportion of conceptual level repairs. Departing from previous work investigating attention and self-repairs, my findings show that attention plays a decisive role in shaping L2 self-repair behavior. Integrating L2 proficiency and L1 repair behavior into the models offers a somewhat more complicated picture. Proficiency was shown to play a very minor role in L2 repair behavior, which was rendered insignificant by the addition of attention-shifting capacity to the model. L1 repairs, in turn, seemed to neutralize the role of attention. However, the strong relationship between attention and L1 repairs suggests that the strong L1-L2 repair relationship is also an expression of a common underlying governing cognitive trait, that is, attention management.

4.2 Future directions

While the present study answered two central questions with regard to the contribution of L2 proficiency, attention management and L1 self-repair behavior to L2 self-repair behavior, it raises questions about the role of other pertinent variables. In this section, I will present avenues for future research targeting task effects (4.2.1), language effects (4.2.2), and variation within other factors such as phonological memory and speaker personality traits (4.2.3).

4.2.1 Task effect

Self-repair researchers have harnessed a variety of techniques for gathering repair data, including communicative tasks (e.g., Griggs, 1997, 2003; Kormos, 1999b, 2000a; Levelt, 1983), recorded discussions (Arroyo, 2003; Blackmer & Mitton, 1991; Brédart, 1991; Fincher, 2006; O'Connor, 1988), and – including the present study – picture-cue tasks (e.g., Simard *et al.*, 2011, van Wijk & Kemper, 1987; van Hest, 1996, Verhoeven, 1989). I chose the elicited narration technique because it has frequently been used to gather relatively realistic speech samples, while maintaining some control over the language elicited. It has, however, been argued that task type can influence certain aspects of oral production such as linguistic complexity (Skehan & Foster, 1997), and fluency and accuracy (Derwing *et al.* 2009). Some researchers (e.g., Tarone & Parrish, 1988; Griggs, 1998, Gilabert, 2007) have even found that task type has a significant impact on how speakers allot attentional resources to the various production processes and, as a result, modify self-repair behavior. As tasks become more open-ended or more complex, they generate more grammatical encoding repairs than restricted tasks such grammatical judgment. It is thus no surprise that conflicting results, such as those presented in Levelt (1983) and van Wijk and Kemper (1987), are partially explained by task effects. Accordingly, the results from the present study should be interpreted as explaining the role of attention as observed through self-repair behavior during monologic narration. Further research will be required to complement previous inquiries on task complexity (e.g., Gilabert, 2007; Griggs, 1998; Tarone & Parrish, 1988) with a measure of attention. This type of research could have very practical applications in terms of determining which types of task conditions are the most amenable to helping low-attention speakers mitigate the negative effects associated with excessive disfluencies or self-repairs.

4.2.2 Language

Not only do speakers manage their own attention, but language itself works to direct language users' attention. Segalowitz, (2010) coined this as language-directed attention. Speech production researchers (e.g., in L1, Langacker, 2008 & Slobin, 1996; Talmy, 1996; in L2, Segalowitz & Frenkiel-Fishman, 2005; Taub-Schiff & Segalowitz, 2005) have investigated the effects of the semantic-grammatical interface on attention, while others (e.g. Gass, Svetics, & Lamelin, 2003; Simard, 2008) have considered the effects of various grammatical classes therein. For example, Langacker (2008) illustrates how language directs attention through what he defines as four aspects of construal. 1) Language can be used to influence the level of specificity with which elements are construed. 2) Language is also equipped with a focusing mechanism, which allows for the foregrounding or back grounding of specific elements within an event frame. 3) Another notion associated with focusing is scope, which refers to the distance the construal places the representation from the viewer. 4) Finally, Langacker refers to perspective, which is the mechanism that directs attention to spatial and temporal aspects of a particular representation. These points illustrate how language directs attention at both the formulator and conceptual levels. Accordingly, my findings are limited to explaining how native French speakers behave within the constraints imposed by the semantic-grammatical structure of French L1 and English L2. A portrait of the role of attention management in L2 speech production would be enriched by similar investigations including other L2s.

4.2.3 Other cognitive factors

In order to enrich the portrait of the interaction between cognitive traits and self-repair behavior, it will be necessary to examine other cognitive factors such as phonological memory and cognitive control. Phonological memory would be expected to play a crucial role in the mechanics of self-repair behavior, in that speakers must retain the reparandum in the phonological loop while the repair is executed, which could have an impact on the well-formedness of repair outcomes. With regard to cognitive control, it would be important to learn how speakers' intentions and task instructions can influence repair behavior while controlling for attention and phonological memory, that is how much can speakers control their self-repair behavior. It would be initially important to determine whether the participants are self-proclaimed frequent (accuracy orientation) or infrequent (fluency orientation) repairers, and to verify how their position translates to actual repair behavior while controlling for attention. With a baseline established, it would be necessary to determine to what point speakers can modify their behavior according to task instructions written to either elicit an accuracy or fluency orientation.

CONCLUSION

This study was conceived and conducted around two research questions. On one level, I aimed to verify whether variation among individual speakers in a processual aspect of attention, referred to as attention management, plays a determinant role in L2 speech production as observed through self-repair behavior. On another level, I intended to determine whether L2 proficiency and L1 self-repair behavior mediated the attention-L2 self-repair relationship.

Let us recall that, in the introduction, I pointed out two general types of self-repair research: language-centered research where researchers have examined the role of factors external to speakers such as language and task type on repair behavior, and speaker-centered research, which has investigated the role of individual difference variables such as L2 proficiency, memory, executive functions and attention. The present study attempted to respond to needs in this second field.

A review of the attention literature allowed me to elaborate a model representing the role of attention during speech production, which depicted attention as existing in multiple unlimited resource pools, wherein performance decrement is the result of inefficient coordination and allocation of attentional resources to the involved cognitive processes. I argued that the best non-invasive way to examine attention-management during speech production was through the observation of self-repairs, which were defined as "revisions of speech that the speakers themselves had initiated and completed" (Salonen & Laakso, 2009, p. 859). Observation of self-repairs allows one to identify the part of the speech production process to which speakers allocate attention to execute the repair, thereby identifying the parts of speech that are also most affected by attention-management related performance decrement. I hypothesized that low-attention management would result in less efficient production processes and an ensuing increase in repair frequency. I further hypothesized that such an increase would be mediated by L2 performance and L1 self-repair behavior. Justification for the L2 performance variable was based on self-repair research revealing such links. The rational for inclusion of the L1 self-repair variable was based on the assumption that L1 and L2 self-repairs are both governed by the same underlying processes, one of which is attention-management.

To find an answer to my research questions, I recruited 58 French L1 English L2 speakers of various L2 proficiencies. Each participant completed a picture-cued narration task in French L1 and English L2, a cloze test (proficiency measure), the Trail Making Test (attention-management measure), and a demographic questionnaire. Self-repairs were identified in the narrations and coded for type. The data were entered into an Excel spread sheet and analyzed using SPSS. Correlations and multiple regressions were used to identify relationships between attention, L2 proficiency and L1 and L2 self-repair behavior. Mann-Whitney U-tests were conducted in order to determine the significance of the repair behavior differences among the high- and low-attention groups.

Concerning general self-repair behavior, the results revealed that the participants repaired 36% more in L2 than in L1 and that the large part of this increase can be attributed to a 61% increase in lexical repairs and a 96% increase in pronunciation repairs. With regard to the variables influencing self-repair behavior, attention management account for 18% of the variance in L2 and 26% of the variance in L1. Attention-management has a stronger influence in L1 than L2. The addition of the other two variables into the models offered a more nuanced portrait. Proficiency explained a mere 5% of the variance in L2 self-repair behavior. Attention management contributed an additional 22% to the model, but proficiency lost significance. Finally, the addition of L1 self-repair behavior contributed another 18%, together explaining 40% of the total variance, but like proficiency, attention-management lost significance. However, the strong relationship between L1 repairs and attention-management capacity suggested that the L1 repair variable was also a measure of attention-management. Furthermore, a comparison of low- and high-attention groups (the high group had an attention score that was 52% higher than the low group), showed that low attention speakers repair 67% more in L2 and 79% more in L1. The increases were roughly the same for F- and C-Repairs.

The sum of our results allowed us to confirm our hypotheses and make the following claims.

1. Attention management capacity contributes significantly to L2 self-repair behavior.
2. Attention management capacity plays an even stronger role in L1 self-repair behavior. This finding suggests that the L2-attention link is mitigated by proficiency factors related to unautomatized formulator processes.
3. L2 proficiency contributes slightly to the shaping of L2 self-repair behavior, while L1 self-repair behavior very strongly predicts L2 self-repair behavior.

Future directions for research should lead to a more complete understanding of the influence of task type and language on self-repairs as a function of attention management. It will also be necessary to examine relationships between self-repair behavior and other cognitive traits such as phonological memory and executive functions.

APPENDIX A – DATA COLLECTION DOCUMENTS

A.1 Questionnaire

A.2 Proficiency Test

A.3 Participant Distribution Form

A.4 Protocol

A.5 Participant Recruitment Form

A.6 Consent Form

APPENDIX A.1

QUESTIONNAIRE

Questionnaire

Speech Production
Name ________________ Date ___________
Participant Number _____ Page 1 sur 2

La production orale en langue maternelle et en langue seconde

Je vous remercie d'avoir pris du temps pour partager des informations à propos de vous et de votre expérience avec l'anglais langue seconde. Les informations que vous nous donnerez seront confidentielles et accessibles seulement aux fins de cette recherche.

Nom: ________________________________ **Âge:** _______ **Sexe:** _________ **Langue maternelle:** ______________

Votre expérience avec anglais langue seconde

1. À quel âge avez-vous commencé à étudier l'anglais? _________

2. Pendant votre enfance, parliez-vous anglais en dehors de l'école pour communiquer avec des ami(e)s?

a) Jamais
b) Parfois
c) Souvent
d) Toujours

3. Actuellement, à peu près combien de temps par jour parlez-vous anglais?

a) Jamais
b) Moins d'une heure par jour
c) Entre deux et quatre heures par jour
d) Presque toute la journée

4. Dans quels contextes utilisez-vous l'anglais le plus souvent?

a) Au travail ou dans des situations professionnelles
b) À la maison ou avec la famille
c) Avec mes amis
d) Dans des magasins et des restaurants
e) Pendant les voyages
f) Autre ________________________________

5. Situez votre attitude envers l'anglais sur le continuum suivant.

Très positif									Très négatif
10	9	8	7	6	5	4	3	2	1

6. Pour moi, pouvoir communiquer en anglais ...

a) est très important;
b) est un peu important;
c) n'est pas très important;
d) n'est pas du tout important.

7. Quel est votre niveau actuel de scolarité ?

a) Cégep
b) Université : premier cycle
c) Université : deuxième cycle
d) Université : troisième cycle
e) Autre ________________________________

8. Quel est votre programme d'étude :

____

APPENDIX A.2

PROFICIENCY TEST

Clozotrophy

PARTICIPANT NUMBER: ______________

DATE: ______________

Us and Them

Dans l'exercice suivant, chaque sixième mot de ce texte en anglais a été supprimé et remplacé par un trou. Vous devez compléter la phrase avec le mot qui vous semble le mieux aller dans l'espace prévu.

Rappelez-vous :

a. N'écrivez qu'un seul mot sur la ligne prévue.
b. Essayez de remplir chaque trou même si vous devez deviner le mot.
c. Vous pouvez laisser vides des trous difficiles et y revenir plus tard.
d. Vous ne serez pas pénalisé(e) pour des fautes d'orthographe.
e. Veuillez écrire lisiblement.
f. Prenez le temps qu'il vous faut pour accomplir la tâche, ce qui normalement demande environ 20 minutes.

WHEN MY FAMILY FIRST MOVED to North Carolina, we lived in a rented house three blocks from the school where I would begin the third grade. My mother made friends with one ______________ the neighbors, but one seemed enough ______________ her. Within a year we would ______________ again and, as she explained, there ______________ not much point in getting too ______________ to people we would have to ______________ good-bye to. Our next house was ______________ than a mile away, and the ______________ journey would hardly merit tears or ______________ good-byes, for that matter. It was ______________ of a "see you later" situation, ______________ still I adopted my mother's attitude, ______________ it allowed me to pretend that ______________ making friends was a conscious choice. ______________ could if I wanted to. It ______________ wasn't the right time.

Back in ______________ York State, we had lived in ______________ country, with no sidewalks or ______________; you could leave the house and ______________ be alone. But here, when you ______________ out the window, you saw other ______________, and people inside those houses. I ______________ that in walking around after dark ______________ might witness a murder, but for ______________ most part our neighbours just sat ______________ their living rooms, watching TV. The ______________ place that seemed truly different was ______________ by a man named Mr. Tomkey, ______________ did not believe in television. This ______________ told to us by our mother's ______________, who dropped by one afternoon with ______________ basketful of okra. The woman did ______________ editorialize—rather, she just presented her ______________, leaving her listener to make of ______________ what she might. Had my mother ______________, "That's the craziest thing I've ever ______________ in my life," I assume that ______________ friend would have agreed, and had ______________ said, "Three cheers for Mr. Tomkey," ______________ friend likely would have agreed as ______________. It was a kind of test, ______________ was the okra.

To say that ______________ did not believe in television was ______________ from saying that you did not ______________ for it. Belief implied that television ______________ a master plan and that you ______________ against it. It also suggested that ______________ thought too much. When my mother ______________ that Mr. Tomkey did not believe ______________ television, my father said, "Well, good ______________ him. I don't know that I believe in it, either."

APPENDIX A.3

PARTICIPANT DISTRIBUTION FORM

Task_Distribution

Speech Production Study
Michael Zuniga
Université du Québec à Montréal

N0	Name	Gr	T1	T2
1		A	FRA	ENB
2		B	FRB	ENA
3		C	ENA	FRB
4		D	ENB	FRA
5		A	FRA	ENB
6		B	FRB	ENA
7		C	ENA	FRB
8		D	ENB	FRA
9		A	FRA	ENB
10		B	FRB	ENA
11		C	ENA	FRB
12		D	ENB	FRA
13		A	FRA	ENB
14		B	FRB	ENA
15		C	ENA	FRB
16		D	ENB	FRA
17		A	FRA	ENB
18		B	FRB	ENA
19		C	ENA	FRB
20		D	ENB	FRA
21		A	FRA	ENB
22		B	FRB	ENA
23		C	ENA	FRB
24		D	ENB	FRA
25		A	FRA	ENB
26		B	FRB	ENA

N0	Name	Gr	T1	T2
27		C	ENA	FRB
28		D	ENB	FRA
29		A	FRA	ENB
30		B	FRB	ENA
31		C	ENA	FRB
32		D	ENB	FRA
33		A	FRA	ENB
34		B	FRB	ENA
35		C	ENA	FRB
36		D	ENB	FRA
37		A	FRA	ENB
38		B	FRB	ENA
39		C	ENA	FRB
40		D	ENB	FRA
41		A	FRA	ENB
42		B	FRB	ENA
43		C	ENA	FRB
44		D	ENB	FRA
45		A	FRA	ENB
46		B	FRB	ENA
47		C	ENA	FRB
48		D	ENB	FRA
49		A	FRA	ENB
50		B	FRB	ENA
51		C	ENA	FRB
52		D	ENB	FRA

APPENDIX A.4

PROTOCOL

Protocol

Michael Zuniga
Attention and Speech Production
Université du Québec à Montréal

Name ____________________ **Participant Number** ________ **Date** ______________

Check each box upon completion of the corresponding task.

1. Materials Check ☐

Verify that the following are in the participant's folder and that each document is labeled with the corresponding participant number: 1 consent form, 1 questionnaire, 1 Trail Making Test packet, 2 blank sheets for narration notes, 1 gift-certificate.

2. Greeting and consent form ☐

Once greeted and seated, ask the participant to read and sign the consent form.

3. Questionnaire ☐

Review the instructions on the questionnaire with the participant before having them complete it.

4. Proficiency Test ☐

Review the instructions on the test with the participants before having them complete it.

5. The Trail Making Test ☐

Give the participant the sample version of test A. Then read and illustrate the following instructions.

> *Cette épreuve consiste en deux parties. Dans cette première partie, vous devez relier au crayon des nombres par ordre croisant le plus rapidement que possible et sans enlever le crayon de la page, les nombres étant disséminés oléatoirement sur la page. Si vous faites une erreur, je vous l'indiquerai et vous aurez une occasion de la corriger. Avez-vous des questions à propos de la tâche avant de la commencer ?*

Read the following instructions before presenting test A. Start the timer as you place the test in front of the participant. Write the completion time directly on the test sheet.

> *Cette fois-ci, vous allez effectuer la même tâche, mais avec 25 nombres disséminés aléatoirement sur la page. Avez-vous des questions à propos de la tâche avant de la commencer ?*

Give the participant the sample version of test B. Then read and illustrate the following instructions.

> *Pour cette deuxième épreuve, vous devez relier alternativement des chiffres par ordre croissant et des lettres par ordre alphabétique. Par exemple, commencez par le numéro un (indiquer du doigt) et tracer une ligne jusqu'à la lettre A (indiquer du doigt). Ensuite, tracer une ligne de la lettre A (indiquer du doigt) jusqu'au numéro deux, une ligne du numéro deux jusqu'à la lettre B (indiquer du doigt), une ligne de la lettre B jusqu'au numéro 3 (indiquer du doigt), et ainsi de suite jusqu'à ce que vous arriviez à la fin (la lettre D). Comme pour l'épreuve A, vous devez reliez les pastilles le plus rapidement que possible et sans enlever le crayon de la page. Si vous faites une erreur, je vous l'indiquerai et vous aurez l'occasion de la corriger. Avez-vous des questions à propos de la tâche avant de la commencer ?*

Read the following instructions before presenting test B. Start the timer as you place the test in front of the participant. Write the completion time directly on the test sheet.

> *Maintenant, vous allez effectuer la même tâche, mais cette fois-ci avec 13 nombres et des lettres (A à L) disséminés aléatoirement sur la page. Avez-vous des questions à propos de la tâche avant de la commencer ?*

6. Narration 1 ☐

Use the distribution sheet to confirm the order of the language in which they will be giving the narration and the story they will use. Install the appropriate Pdf of the story in "slide show" mode. Have the participants sit in front of the computer. Give them a sheet of scrap paper and read the following instructions.

> *En regardant les images sur l'écran devant vous, vous allez devoir raconter l'histoire illustrée dans les images en (anglais/français) pendant entre 4 et 5 minutes. Vous avez 5 minutes pour vous préparer. Vous pouvez prendre quelques notes pendant la planification sur la feuille que je vous donne à cet effet, mais vous n'aurez pas le droit de les regarder pendant que vous racontez l'histoire. Vous avez aussi le droit de me demander des mots de vocabulaire pendant votre planification.*

7. Narration 2 ☐

According to the task distribution sheet, set up the second story and repeat the instructions above, changing the narration language.

NOTE: While the participant is finishing the second narration, verify that all documents have been completed, properly labelled and are returned to the file folder.

8. Gift certificate ☐

Give the give certificate to the participant and thank him or her for his or her participation.

APPENDIX A.5

RECRUITMENT FORM

Recruitment

Speech Production Study
Michael Zuniga
Université du Québec à Montréal

Bonjour !

Je m'appelle Michael Zuniga. Je suis doctorant dans le département de linguistique à l'UQÀM et je mène présentement une étude portant sur la production orale des francophones en anglais langue seconde. Je cherche actuellement des participants (français langue maternelle) pour mon expérimentation dans laquelle ils accompliront 4 tâches, dont un questionnaire, une courte épreuve psychométrique, ainsi qu'un échantillon de production oral en français et en anglais. Toute l'expérience durera moins d'une heure avec une rémunération de 20 $.

Si vous pensez que vous seriez intéressé(e) à participer à cette étude, écrivez votre nom et votre courriel (le numéro de téléphone est facultatif) ci-dessous, et je vous contacterai dans les 24 heures afin de vous donner plus d'information et de répondre à toutes vos questions.

Cordialement,

Michael Zuniga

mail@michaelzuniga.com

514-231-9454

Nom	Courriel	Téléphone (facultatif)
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )
		( )

APPENDIX A.6

CONSENT FORM

Consentement

Nom du chercher: Michael Zuniga
Université du Québec à Montréal
Département de linguistique

Étude sur la production orale en langue seconde

Objectif

Cette étude a comme objectif d'étudier la production orale en français langue maternelle et en anglais langue seconde.

Participation à l'étude

Votre participation à cette étude se résume à 5 tâches : un questionnaire à propos de vos habitudes quant à la langue anglaise; deux épreuves psychométriques; deux courtes narrations (en français et en anglais) à partir d'une série d'images. La durée de l'expérience ne devrait pas dépasser une heure.

Inconvénient à participer à cette étude

Le seul inconvénient à votre participation à cette recherche est le temps consacré aux tâches.

Avantages à participer à cette étude

Vous contribuez à l'avancement des connaissances dans le domaine de la production orale en langue seconde.

Confidentialité

Les informations que vous nous donnerez seront confidentielles et accessibles seulement aux fins de cette recherche. Seuls les membres de l'équipe de chercheurs pourront avoir accès aux données cueillies. Les informations seront conservées de manière confidentielle et seront détruites trois ans après la dernière publication ou communication.

Votre consentement

J'accepte de participer à la recherche sur la production orale en langue maternelle et en langue seconde. Ma signature atteste de mon consentement à participer à l'étude. Je comprends que je suis libre de me retirer en tout temps de l'étude sans aucune conséquence pour moi.

Signatures

Signature de l'informateur ____________________

Signature de l'agent de recherche ____________________

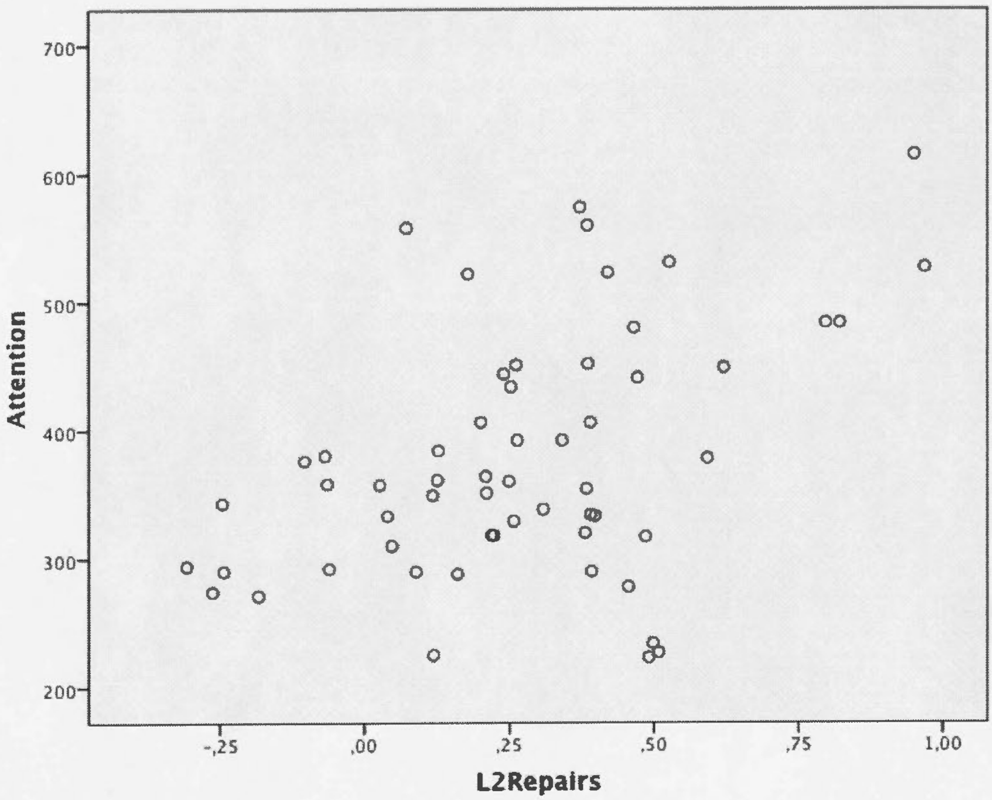
Lieu et date

____

APPENDIX B – ANALYSIS SUPPLEMENTS

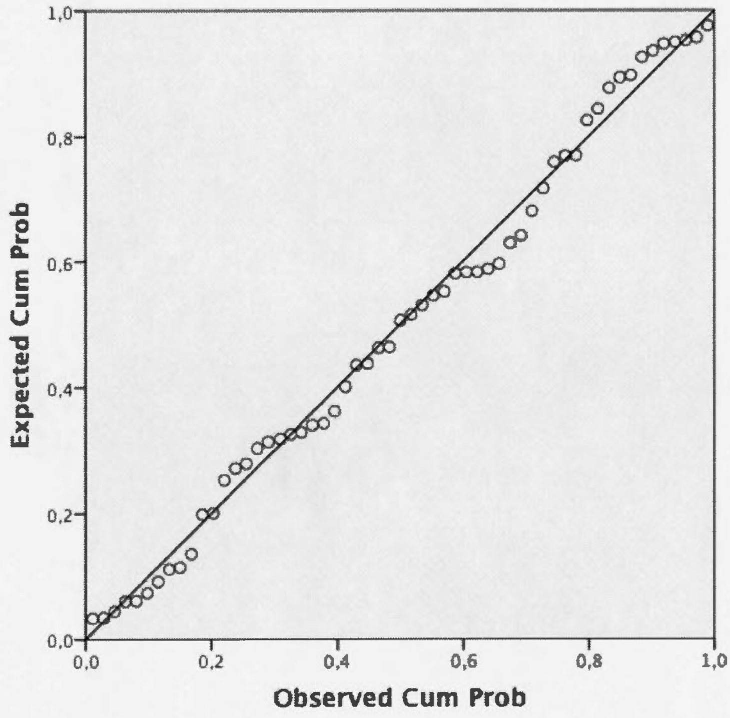
APPENDIX B.1

DISPERSION OF VALUES FOR ATTENTION AND L2 SELF-REPAIRS



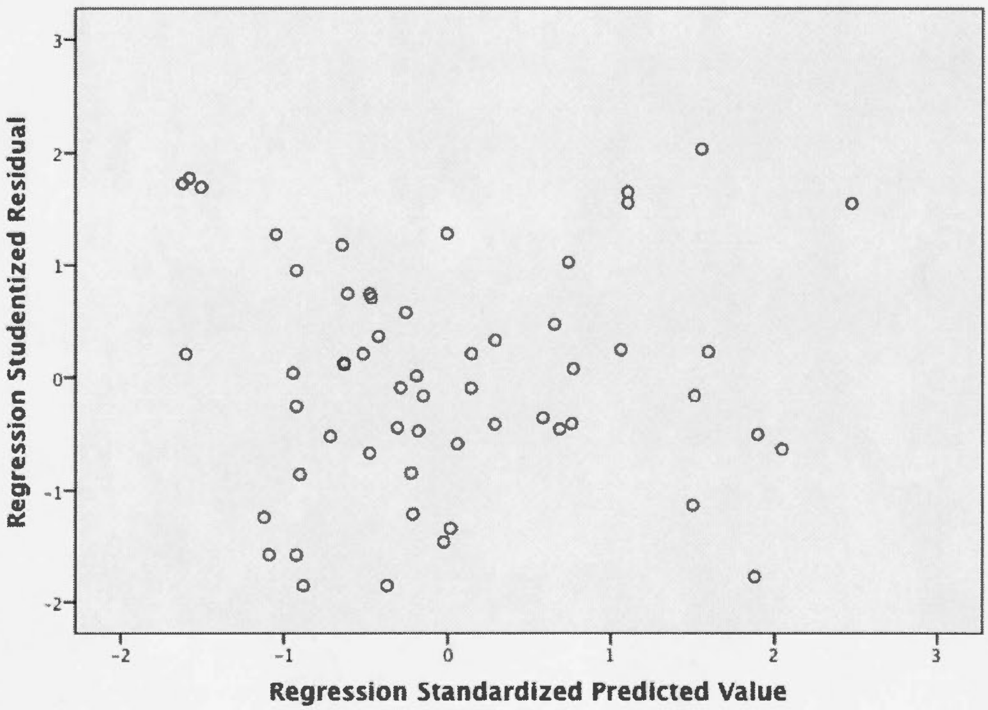
APPENDIX B.2.

P-P PLOT FOR DIAGNOSING NORMAL DISTRIBUTION OF DATA, DEPENDENT VARIABLE: L2 SELF-REPAIRS



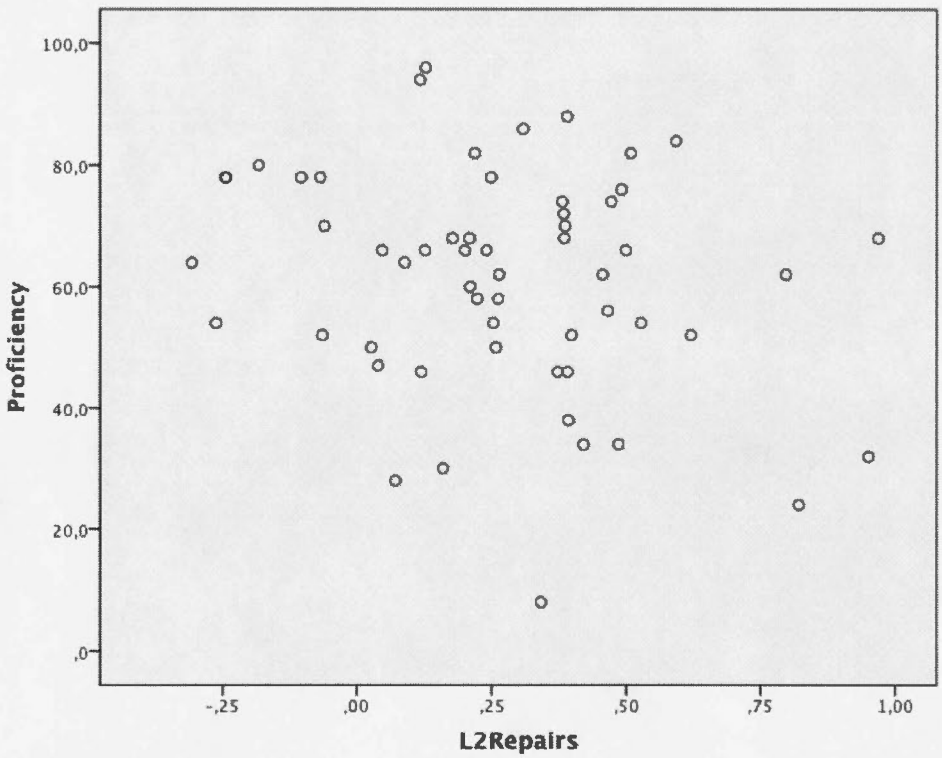
APPENDIX B.3

PLOT OF STUDENTIZED RESIDUALS, DEPENDANT VARIABLE: L2 SELF-REPAIRS



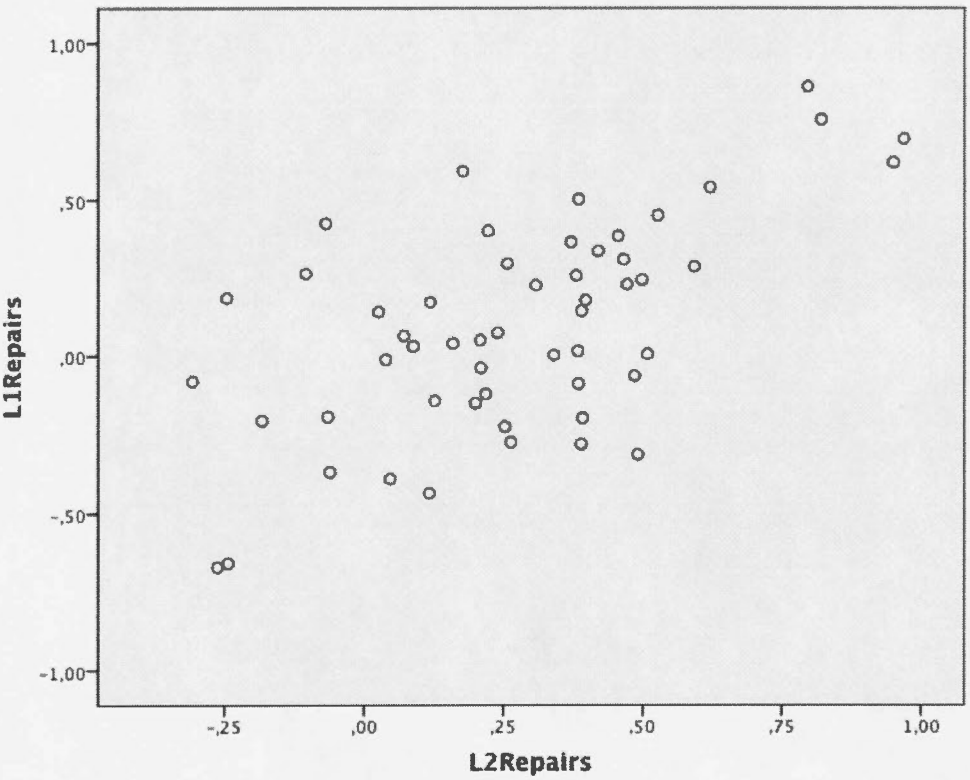
APPENDIX B.4

DISPERSION OF VALUES FOR PROFICIENCY AND L2 SELF-REPAIRS



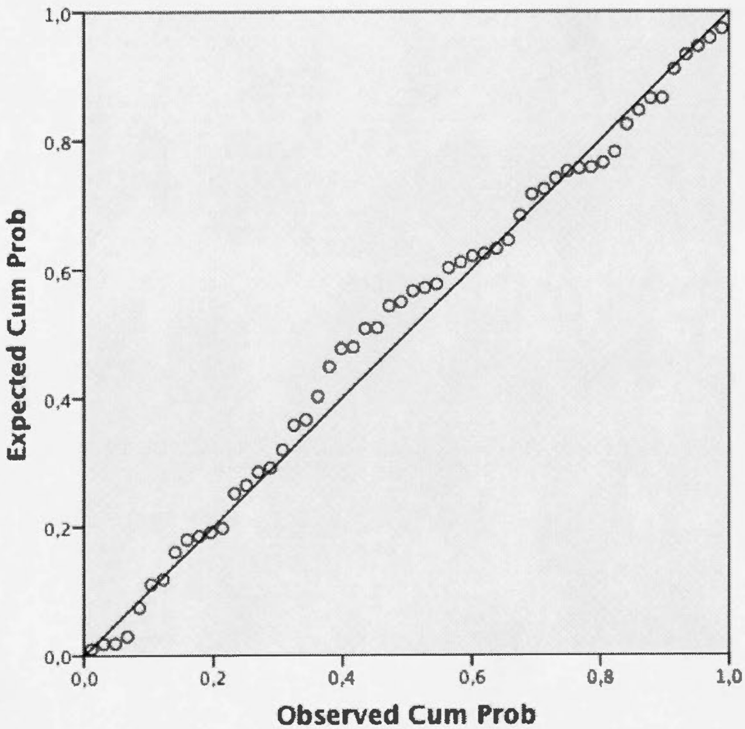
APPENDIX B.5

DISPERSION OF VALUES FOR L1 SELF-REPAIRS AND L2 SELF-REPAIRS



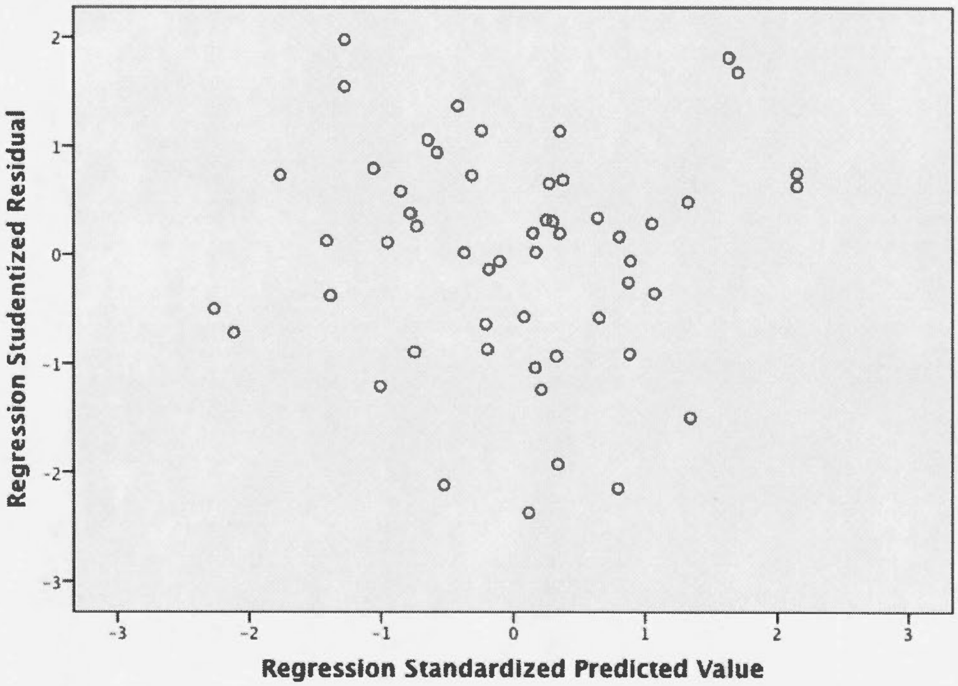
APPENDIX B.6

P-P PLOT FOR DIAGNOSING NORMAL DISTRIBUTION OF DATA, DEPENDENT VARIABLE: L2 SELF-REPAIRS



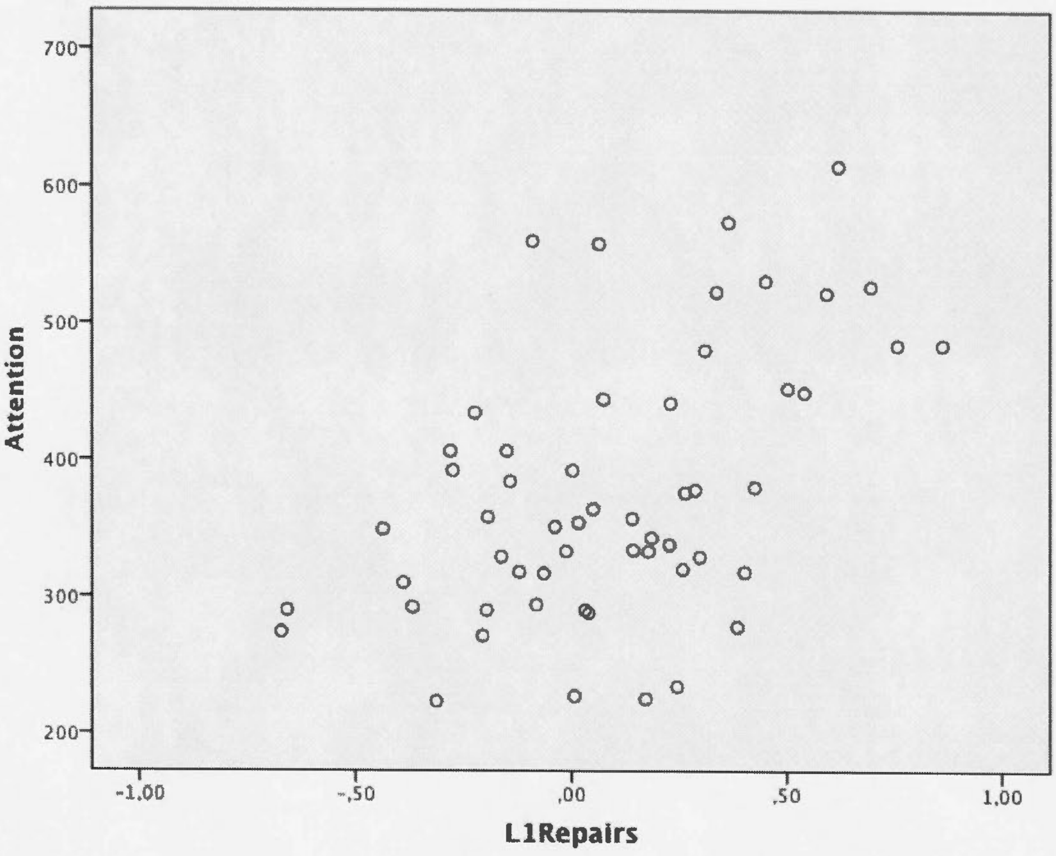
APPENDIX B.7

PLOT OF STUDENTIZED RESIDUALS, DEPENDENT VARIABLE: L2 SELF-REPAIRS



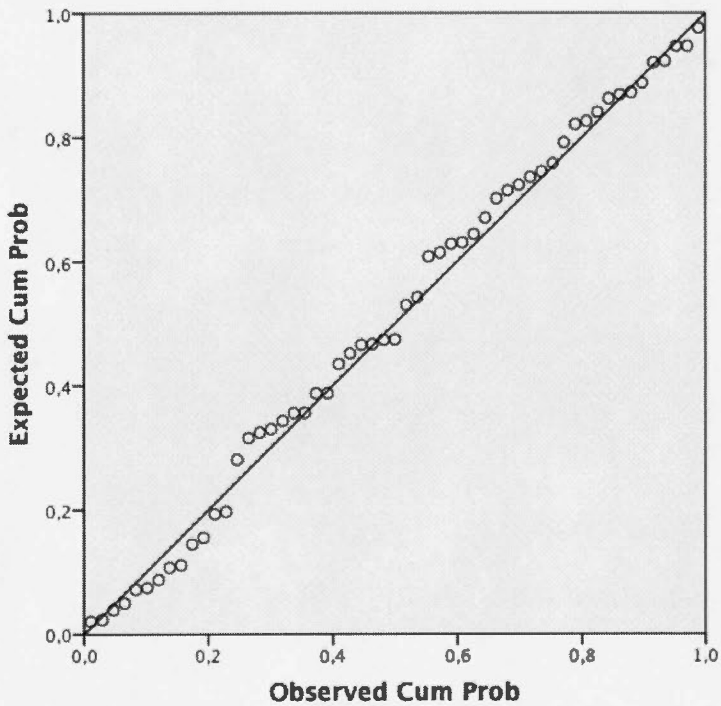
APPENDIX B.8

DISPERSION OF VALUES FOR ATTENTION AND L1 SELF-REPAIRS



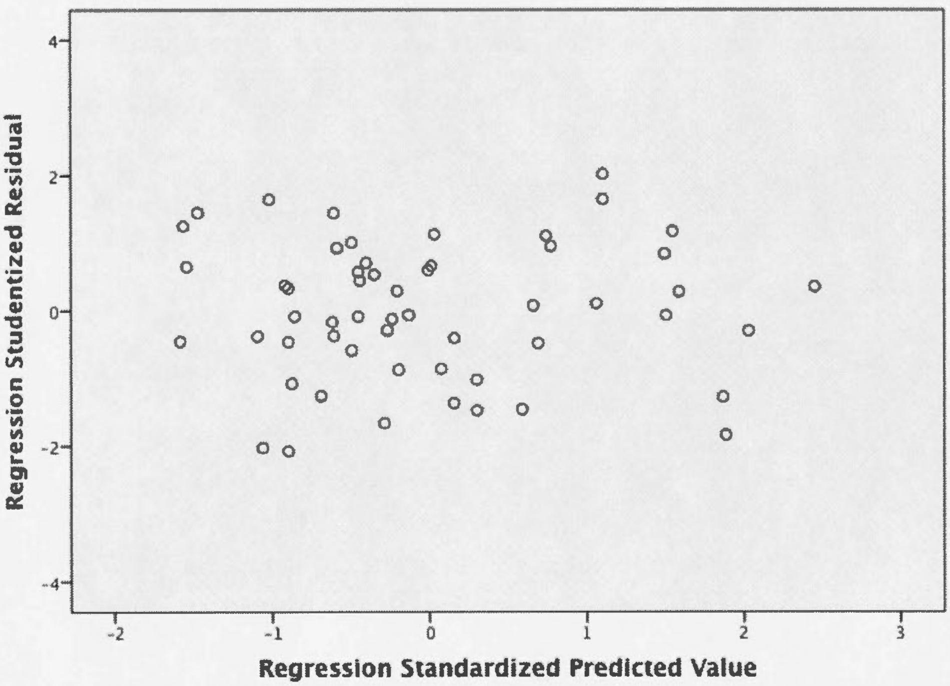
APPENDIX B.9

P-P PLOT FOR DIAGNOSING NORMAL DISTRIBUTION OF DATA,
DEPENDENT VARIABLE: L1 SELF-REPAIRS



APPENDIX B.10

P-P PLOT FOR DIAGNOSING NORMAL DISTRIBUTION OF DATA, DEPENDENT VARIABLE: L2 SELF-REPAIRS



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