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Relative Clause Ambiguity Resolution in L1 and L2: Are Processing Strategies Transferred?

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Abstract

This study aims at investigating whether Persian native speakers highly advanced in English as a second language (L2ers) can switch to optimal processing strategies in the languages they know and whether working memory capacity (WMC) plays a role in this respect. To this end, using a self-paced reading task, we examined the processing strategies 62 Persian speaking proficient L2ers used to read sentences containing ambiguous relative clauses in their L1 and L2. The results showed that L2ers adopt the same strategy as that used by English native speakers in both of their languages, indicating a target-language like parsing pattern in their L2 and an attrition of L1 parsing routine. Additionally, their attachment preferences were not modulated by WMC in L2. This result highlights the "skill-through-experience" position adopted by researchers who question the role of WMC in L2 syntactic parsing. However, high-capacity L2ers' preferences in L1 had attrited (becoming English-like), and low-capacity ones had no preference. This modulation, too, can bear out the above position owing to the observation that L2ers failed to differentiate between their L1 and L2, and particularly that their differing WMCs did not contribute to native-like performance in their L1.

Keywords: Attrition; Bilingual parser; Processing transfer; Relative clause ambiguity; Working memory capacity

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1. Introduction

Multilingualism, throughout the years of study, has been recognized to step beyond its limits to enter an era of neuroplasticity in language learning (Kasparian & Steinhauer, 2017). A reason for such flexibility is the recognition that the moment a second language enters a monolingual mind, the bilingual cannot use either of the languages in the way generally characterized with the monolingual use. Since bilinguals seem to have access to both of their languages while processing any of them, a return to the monolingual mode would not be potentially possible (Dijkstra & Van Heuven, 2002; Grosjean, 1989). This state leaves open the opportunity for the language systems to have an effect on their joint conceptual system in such a way that even if a bilingual might want to express his/her thoughts in one language, the L1/L2 related thoughts seep into the existing language channels, impacting upon native-like performance (Kecskes, 1998). Therefore, according to Green's (1998) Inhibitory Control Model, inhibitory control must be exercised by bilinguals over the language not presently opted for in order to impede its force in directing performance. Within this model, item retrieval would be such that the items which have been most recently used and, therefore, reinforced would be more accessible than the ones which have not. That is, in a context where L2 is acquired and used and where L1 is rarely heard around, bilinguals might reach a point where the processing of L1 is characterized not only by a relative deceleration in its use, but also by its gradual evolution into L2 in some respects (Cummins & Swain's (1986) Interdependence Hypothesis) and where the absence of congruence between the two languages eventually culminates in difficulties in L1 performance, i.e., First Language Attrition (FLA) (Cook, 2003; Pavlenko, 2000). Accordingly, it does not appear sensible enough to expect native-like performance by bilinguals (Cook, 1992; Coppieters, 1987).

Investigation into how the parser sets out to interpret constructions, such as complex sentences can shed light on the interaction of the languages in mind (Kecskes, 2008). That is why the processing of sentences with ambiguous Relative Clauses (RCs) has appealed to many researchers. A classic example of this type of structure is: *someone shot the maid of the actress who was on the balcony.* In this sentence, the RC *who was on the balcony* can refer back to either of the Determiner Phrases (DPs), *the maid* (DP1, High Attachment (HA)) or *the actress* (DP2, Low Attachment (LA)). Faced with ambiguous constructions, the parser may, out of a handful of choices available to resolve the ambiguity, opt for an assignment to a recent constituent, i.e., *the actress was on the balcony*. That is, following the Recency principle (Gibson, Pearlmutter, Canseco-Gonzalez, & Hickock, 1996), which is a corollary of general human parsing architecture, the more recently built structures would be better hosts for the new incoming materials. However, Cuetos and Mitchell (1988) provided evidence against this assumption (Frazier & Clifton, 1996) in Spanish. The overriding focus on cross-linguistic preference variances in syntactic ambiguity resolution (Grillo & Costa, 2014; Kamide & Mitchell, 1997; Papadopoulou & Clahsen, 2003) was, therefore, initiated by Cuetos and Mitchell's work. Since then, a number of studies with monolinguals and bilinguals offered evidence to corroborate this variability.

Many researchers in L2 development (Chaudron, 1985; Juffs & Harrington, 1995) have speculated that the incomplete acquisition extensively observed in advanced L2 speakers of a language might stem from dysfunctional processing mechanisms – transfer (e.g., Jarvis, 2002; Linck, Kroll, & Sunderman, 2009) – applied by them (Clahsen & Felser, 2006; Jiang, 2007). In spite of the existence of a robust literature on forward transfer (e.g., Foucart & Frenck-Mestre, 2012; Sabourin, 2003), evidence

buttressing the role played by L2 while processing L1 has been rather scattered as the concept has, so far, been given only a scant amount of consideration (Frenck-Mestre & Pynte, 2000; Linck,, Kroll, & Sunderman, 2009; Timmer, Ganushchak, Ceusters, & Schiller, 2014). More specifically, an in-depth enquiry into the modifications caused in L1 neurocognitive processing system as a result of acquiring an L2 (Kasparian & Steinhauer, 2017) and into the ability of the parser to switch to parsing variations associated with a specific language has been left relatively unexplored. In addition, the literature on syntactic processing has, to some extent, attended to the role of L2 on L1 linguistic aspects (Brien & Sabourin, 2012; Tsimpli, Sorace, Heycock, & Filiaci, 2004) or on L1 processing with participants in an immersion program (Dussias, 2003; Dussias & Sagarra, 2007). What has been accordingly observed is that the participants, having learned L2 in a second or foreign language context, failed to show native-like performance in their L1.

Ambiguity resolution preferences of native speakers of a language are regarded to reflect certain ways of organizing thoughts (Kecskes, 2008). Performing like target-language native speakers when resolving ambiguity can imply that acquiring a high level of linguistic proficiency in an L2 can entail the acquisition of its respective processing routines, as well. This article, therefore, examines the capability of highly proficient bilinguals to switch to RC ambiguity resolution parsing strategies associated with a specific language presented to them, being either L1 or L2, in order to examine whether L2ers can organize their processing in line with their target language counterparts and whether they can retain their L1 processing patterns, as well. What has additionally been considered is whether or not learning a second language in a foreign-language context can indeed equip

bilinguals with the processing tools necessary to perform like the L2 natives.

2. Review of the Related Literature

Variation in RC attachment preference within the speakers of a same language (Fernandez, 2003; Kamideh & Mitchell, 1997; Pynte & Colonna, 2001) and of different languages (Clahsen & Felser, 2006; Frazier & Clifton, 1996) has been reported. Such variations have been partly accounted for in terms of the frequency with which they have been encountered. Experience-or Expectation-Based Models, such as Tuning Hypothesis (Cuetos, Mitchell, & Corely, 1996) assume that ambiguities are interpreted in a way that is most frequently resolved in the language the individuals are exposed to. Memory constraints, viewed as a form of individual experience (MacDonald & Christiansen, 2002), have also enjoyed accountability power (Caplan & Waters, 1999; Hopp, 2014; Just & Carpenter, 1992; Kim & Christianson, 2012; Waters & Caplan, 1996). This claim supports the Capacity Constrained Parsing Model of sentence processing (MacDonald, Just, & Carpenter, 1992). The model underscores the notion that it is the differences in Working Memory Capacity (WMC) – which is in charge of a temporary retainment of information in mind to carry out cognitive tasks (Juffs & Harrington, 2011) – that bring about constraints while processing input. The constraint would be such that processing is initially informed by multiple constructions of representations – Parallel Sentence Processing models (e.g., Pearlmutter & MacDonald, 1995) – which are later on modulated by WMC. The Skill-Acquisition Theory (Anderson, 1983) also attributes deviations from native-speaker processing of the L2 speakers to the fact that computational resources are drawn upon more by bilinguals than by monolinguals (Schmit, 2009) as the neurocognitive basis that L1 and L2 hinge on are subsumed under differing

memory systems (Paradis, 2004; Ullman, 2001). However, with increasing proficiency, L2ers can attain native-like ability to use L2 morphosyntactic information in addition to processing routine symmetry (Jackson & Bobb, 2009; McLaughlin et al., 2010). What can be a related consideration is the ability of highly proficient bilinguals to switch to the parsing preferences in the languages known by them.

Does WMC really count? Regarding the contribution of memory resources to the processing of ambiguous RCs (e.g., Hopp, 2014; Kim, 2010; Kim & Christianson, 2012; Omaki, 2005), WMC has been recognized to engender different preference patterns. What this difference might mean is that it is the type of processing task that determines the extent to which WMC will be called for. Mixed findings in processing may, thus, on a more secure footing, be attributable to and modulated by individual differences, such as personal language experience and expertise (Ericsson & Kintsch, 1995). Moreover, a skeptical attitude towards the contribution of WMC in syntactic parsing has been adopted by several researchers (Caplan & Waters, 1995; Just & Carpenter, 1992; Just, Carpenter, & Keller, 1996). Through adopting a "skill-through-experience" position, for example, MacDonald and Christiansen (2002, p. 43) have maintained that the traditional line drawn between "language processing tasks" and "linguistic working memory tasks" (p. 49) is a spurious one in that these tasks all target the same construct, being language processing skill. Based on this position, variations in skills can be held responsible for differences in the degree of exposure to language and to biological differences. Within this perspective (MacDonald & Christiansen, 2002), working memory tasks are viewed as tasks imposing demands of varying degrees upon individuals, predisposing them to meet those demands through using their specific comprehension abilities.

Empirically too, little evidence in favor of WMC's potential in inducing particular processing differences has been reported (Caplan & Waters, 1995, 1999; Just & Carpenter, 1992; Just, Carpenter, & Keller, 1996). For example, MacDonald, Just, and Carpenter (1992) selected locally ambiguous sentences as the focus of their self-paced reading investigation. What the researchers uncovered was that it took longer for the high-capacity individuals to read the sentences than the low capacity ones. This paradoxical finding was interpreted as the high capacity participants' constructing and holding active all the possible interpretations in mind until the ambiguity was resolved, while low capacity participants went for the easiest analysis in order to make up for their limited capacities. Research on the processing of nonlocal syntactic constituents has sometimes been found to be invulnerable to WMC effects, as well (Felser & Roberts, 2007; Juffs, 2004; Nakano & Wang, 2011; Omaki, 2005). As an example, Omaki (2005) included advanced Japanese speakers of English in his study of RC ambiguities of embedded (a) and complement types (b) as in:

a. The babysitter that the sister of the schoolgirl who burned herself the other day adored
was very nice.
b. The babysitter said that the sister of the schoolgirl who burned herself the other day
was very nice.

Based on the results, WMC did not affect the attachment preferences which were not following a clear pattern regardless of the RC type.

Moreover, in the eye-tracking study of ambiguous sentences by Nakano and Wang (2011), intermediate-to-advanced Japanese speakers of English were given a close look in terms of WMC contribution in their processing of

L2 global ambiguity. The high WMC individuals chose HA interpretation offline, whereas no attachment preference was detected for the low WMC group. Inconsistency was further observed during online reading, as the high-span and the low-span groups failed to demonstrate a particular type of preference. This observation led the researchers to conclude that WMC does not impact L2 attachment preferences in a systematic fashion.

In spite of numerous cross-linguistic studies that have examined RC attachment preferences and the different features posited to influence them (e.g., Gilboy, Sopena, Clifton & Frazier, 1995; Papadopoulou & Clahsen, 2003), a revealing area of study would be reached by examining the human processing capacity and by studying whether bilinguals can employ relevant parsing strategies in the languages they are exposed to. L2 considerations of WMC, to date, have mostly aimed at identifying its role as a distinguishing factor between native-like and non-native-like performance on syntactically ambiguous sentences (Hopp, 2013; Miyake & Friedman, 1998). One of the other widely studied areas of WMC has been L2 speakers' interpretation of structurally ambiguous sentences by increasing the load on WMC (e.g., Hopp, 2014; Miyake & Friedman, 1998) with different types of complex structures. WMC contribution to the ability of highly proficient L2 speakers to utilize processing strategies similar to native speakers in any of the languages they know with regard to the effects that these languages might have on each other would be an extension of the potential of memory resources to sentence processing.

3. The Study

This study aims at adding to the literature on L2 processing through identifying what might cause bilinguals to deviate from parsing preferences in their L1 or L2. In this regard, non-linguistic accounts, such as those based

on memory or language experience (Cuetos, Mitchell, & Corley, 1996; Frazier, 1987) might be a good reference-point capable of explicating countless preference patterns. These accounts attribute differing processing preferences to individual particularities and their specific language experiences. Therefore, we focused on the role of non-linguistic accounts through examining the role of WMC in modulating the impact of L2 on L1 RC ambiguity resolution. To do so, the processing performance of highly proficient L2 speakers who learned L2 in a classroom environment, not in an immersion program, was taken into account in a self-paced reading experiment in order to interpret the offline and the online data against each other. If such an undertaking results in the same finding obtained in immersion programs, one can propose that a mere contact with an L2 would suffice to alter one's L1 system, the Interdependence Hypothesis of Cummins and Swain (1986). If L1 is not altered as a result of L2 acquisition, out-of-context language development can be proposed to leave L1 free of its interfering influence. Therefore, the following research questions were formulated (all the hypotheses proposed were null):

1. Do monolingual Persian native speakers with different WMCs parse Persian sentences with ambiguous RCs differently offline?
2. Do monolingual Persian native speakers with different WMCs parse Persian sentences with ambiguous RCs differently online?
3. Do Persian L2ers of English with different WMCs parse English sentences with ambiguous RCs differently offline?
4. Do Persian L2ers of English with different WMCs parse English sentences with ambiguous RCs differently online?
5. Do Persian L2ers of English with different WMCs parse Persian sentences with ambiguous RCs differently offline?
6. Do Persian L2ers of English with different WMCs parse Persian sentences with ambiguous RCs differently online?

4. Method

Experiment 1

4.1. Participants

Sixty-two Persian speaking L2ers of English, all English language teachers in Iran Language Institute, participated in this study. The L2ers were from 20-45 years of age, with no knowledge of any language other than Persian and English. The participants were not told anything about the focus of the study, and they reported to have acquired Persian as their mother tongue and to have started learning English in a foreign-language context at roughly the same age.

4.2. Instruments

The instruments utilized included: a proficiency test, a grammaticality judgment test, an operation span task, and a paraphrase decision task in English.

Proficiency test. The proficiency level of L2ers was determined through Oxford Placement Test 2 (OPT 2; Allan, 2004). The test consisted of 100 grammatical items in a written multiple-choice format. In order to be identified as L2ers with professional command, the participants were required to get scores higher than 70 on the test. The range of the scores the participants received on this test was 75-100, with the mean holding the value of 89.4. The reliability of the test, determined through Cronbach's alpha, turned out to be .79.

Grammaticality Judgment Test (GJT). The purpose for the inclusion of this test was to ensure that L2ers were familiar with the structure of the

ambiguous sentences. The test was presented in a paper-and-pencil format and included 20 (10 grammatical and 10 ungrammatical) items enjoying a structure similar to the experimental sentences. For example:

1) The reporter phoned the boss of the secretary who was reading a book.
2) * The nurse of the patient who were feeling very tired recognized the doctor.

The participants were required to rate the sentences on a scale from 1 (least acceptable) to 6 (most acceptable). The highest possible score was 70, and an accuracy score above 63 (93%) was called upon.

Operation Span Task (OST). In order to measure the participants' WMC, an OST (Conway, et al., 2005) was designed and administered using E-Prime. The purpose for the inclusion of this task as opposed to other measures (e.g., reading span task) was that it is language-independent. This consideration is important since the role of the language of WMC tasks (whether it is in L1 or L2) has been shown to be controversial, resulting in differing WMC scores (Alptekin & Gulcan, 2010; Juffs & Harrington, 2011). Furthermore, it has been proposed that OST can predict accuracy for syntactically complex sentences, while other tasks, such as reading span ones have been shown to predict sentence-comprehension performance (O'Rourke, 2013).

The task had four sets of mathematical equations including two to five strings per set. Each set (item) incorporated five trials making up a total of seventy strings in whole ($5 \times (2 + 3 + 4 + 5) = 70$). Each equation had two parts, i.e., an operation and its solution. Out of 70 equations, half had correct and the remaining half had incorrect answers. Each equation, with a question mark at its end, would appear on the monitor through pressing the space bar. Having solved the equation, the participants would indicate

whether the solution was right or wrong by pressing either "Y" or "N" buttons. Thereafter, a capital alphabet letter would appear and it was required to be read aloud and kept in mind. The remaining strings would also appear in the same fashion and the letters following them would be required to be recalled and reported on a paper at the end of each set followed by three question marks. A sample of a two-string set is:

3) (8 + 6) - 2 = 12 "?" F
   3 + (4 - 2) = 5 "?" E
   "???"

For scoring, two sets of scores were reported, one for the equations solved correctly and another for the letters remembered correctly. If the accuracy of the equation-solving section – used to make sure the participants were on the task – fell below 85%, the entire data set for that participant was discarded; if not, the scores on the letters recall section would be the participants' WMC scores. All-or-Nothing Load scoring procedure was employed. According to the procedure, the correct serial order of the letters counts, and "Counting all items equally is done by scoring each item as a proportion of correctly recalled elements per item, regardless of item size" (Conway et al., 2005, p. 8). Then, the proportions are averaged, resulting in a range of scores from 0 to 1.

Paraphrase Decision Task (PDT). This task included 20 experimental items, each followed by a paraphrase of that sentence. Four versions of this PDT were used. The first two were counterbalanced in a Latin square design; so, the sentences with a HA and a LA paraphrase in the first version appeared with a LA and HA one in the second version. Each of these versions appeared once in forward and once in reverse order, making up a total of four versions. Each participant saw only one version, which had warm-ups (N = 3), fillers (N = 40), and experimental sentences (N = 20). All the

versions started and ended with two fillers, and the item presentation was pseudo-randomized such that two fillers were present between two experimental items. The task was implemented using E-prime, and the participants indicated their preferences by pressing "Y" or "N" buttons. If Yes was chosen in response to a HA paraphrase, then it was interpreted as a signal of HA preference. If No was the answer, the preference would be taken to be LA. If Yes was the response to a LA paraphrase, that would mean a LA preference; if No was chosen in response to the same paraphrase, it would be an indication of a HA preference. Longer Yes responses indicated attachment preferences that were not consistent with the given paraphrase.

Experimental sentences. The experimental sentences were all globally ambiguous which included complex DPs of the DP-of-DP type as the subject. Both DPs were animate, and care was taken to eliminate any semantic relationship between the DPs and the RC following them. Furthermore, the nouns in both DPs were from among highly-frequent words of English (Davis & Gardner, 2010). The sentences enjoyed the same number of words in their DPs, almost the same number in RCs and in what followed the RCs, making up sentences with almost equal lengths (14 to 17 words). The verbs in the main and embedded clauses were active and were in the past tense. The RCs were introduced by the relative pronoun *who* and could refer back to both DP1 and DP2. A sample experimental sentence comes below:

complex DP RC

4) [The assistant of the chief] [who was hiding in Taipei] managed to misinform the police.

Each sentence was followed by a paraphrase which referred to either DP1 or DP2. Both paraphrases were accurate, and they included 5 to 9 words. Paraphrases of sentence 5 above include:

5) HA: The assistant was hiding in Taipei.

6) LA: The chief was hiding in Taipei.

Fillers. The purpose for the inclusion of fillers was to distract the participants from what the purpose of the study was and to make sure that the participants paid attention to the content of the sentences. Additionally, as the experimental sentences did not have correct responses and just signaled preferences, it was possible that responses were given with no attention to the content of the sentences and simply through pressing Y or N. Fillers, though, thanks to their having correct and incorrect responses, removed such not-being-on-the-task possibility. The participants with less than 75% accuracy in replies to fillers were excluded. Fillers had various grammatical structures including unambiguous RCs (introduced by a variety of relative pronouns) with simple DPs as antecedents, and were matched with experimental sentences in length. Each filler was followed by a sentence which was correct in half of the items and wrong in the other half, for example:

7) The son was at a situation where he easily betrayed his father's confidence.

The son was loyal to his father.

Warm-ups. Each version included three warm-ups in order to familiarize the participants with the way to get on with the experiment. These sentences were the same across the four versions. The length, complexity, and structure of these sentences were matched with those of the experimental

sentences, with the distinguishing feature that they were not ambiguous. Like the experimental sentences, the participants were asked to determine whether the paraphrase following them was correct or not. An example includes:

8) The waitress who always served us in that restaurant is from Japan by origin.

The waitress serving in that restaurant comes from Japan.

The participants were free to ask questions regarding the sentences, software, etc. If the participants showed that they knew what they were supposed to do throughout the experiment, then the experiment started; otherwise, the warm-up was repeated.

4.3. Procedure

Having determined the proficiency level of the L2ers through OPT and making sure that highly proficient ones were selected, the GJT was administered to ensure they were familiar with the structure of the focus. Thereafter, the proficient L2ers were individually presented with the English PDT using E-Prime to determine their RC attachment preferences through their choices, which would reveal the possible impact of the languages on each other (forward or backward transfer). The task required them to first read the warm-ups, and then, the experimental and filler sentences appeared in their specified order of each version. Through pressing the spacebar, a sentence would appear on the screen; another press was needed for this sentence to go and for its paraphrase to be shown. The participants indicated their preferences by pressing Y or N buttons. The next step was to measure the WMC of the participants in order to examine its role in attachment preferences or in the symmetry of L1 and L2 preferences with their

respective native-language ones. To do so, the L2ers completed an OST, implemented using E-prime, which required them to solve equations and indicate their truth or falsity together with an additional requirement to recall the specified letters.

Experiment 2

4.4. Participants

The L2ers who took part in Experiment 1 participated in the second one, too. An additional group of monolingual Persian native speakers (N = 35) with little or no knowledge of any other language also participated. The monolinguals, within the age range of 14-16, were high-school students, and provided a baseline to draw comparisons between their and the L2ers' preferences in Persian.

4.5. Instruments

The instruments used were a Persian PDT and a WMC task.

PDT. The experimental sentences used in Experiment 2 were literal translations of those used in Experiment 1. The translations were done by two Persian native-speakers who were English teachers and further checked by a monolingual Persian native to make sure that they sounded natural. The translations did not remove the ambiguity of the sentences. The L2ers and the monolinguals were required to indicate their preferences. The task, including the experimental sentences (12 to 16 words with 5 to 10 words in the paraphrases following them), warm-ups, and fillers (with similar lengths), appeared on the screen using E-Prime. Like Experiment 1, the task included four versions, consisting of experimental sentences with ambiguous RCs. Each sentence was followed by a paraphrase which disambiguated toward either HA or LA, for example:

9) مربی آن قهرمان که در دهات زندگی میکرد با اتوبوس عازم سفر پرماجرایی شد.
مربی در دهات زندگی میکرد.

10) خدمتکار آن هنرمند که در بالکن بود با جدیت تمام به اطراف نگاه میکرد.
آن هنرمند در بالکن بود.

This task also included the same warm-ups and fillers in the English task which were translated into Persian, examples of which are:

11) اصول اخلاقی که ما همگی به آنها معتقدیم بر پایه یک اصل کلی میباشند.

اصول اخلاقی ما برخلاف یک اصل کلی میباشند.

12) خبرنگاری که با پیرزن در اتاق مجاور صحبت میکرد آن منشی را دید.

خبرنگار با یک مرد صحبت میکرد.

4.6. Procedure

The procedure to get on with the PDT and the WMC task, which could also be administered to monolinguals thanks to its inclusion of mathematical operations, was exactly the same as in Experiment 1.

5. Results and Discussion

The results of both experiments are collectively reported below:

Data trimming. Throughout the data trimming stage for fillers (75% accuracy needed), 5 monolinguals, 1 L2er taking the test in Persian, and 4 L2ers taking the test in English were excluded. Furthermore, the distribution of the time it took to indicate the truth or falsity of each preference was detected for outliers for each participant in each condition. Thus, values 1.5 times the interquartile range above the 75^{th} percentile or below the 25^{th}

percentile were detected and substituted by the mean for that participant in the condition where the outlier located. In this way, 1.83% of the data from the monolingual group, 2.46% of the data from the L2er group who received the test in Persian, and 3.02% of the data from the L2er group who received the test in English were detected and substituted by the mean time of each participant in the relevant condition.

Classifying preferences. Following the trimming of the data, the responses for each item were coded as representing high or low attachment. Having identified the preference for each item through classifying Yes or No responses to the paraphrases, the scores of 1 and 0 were respectively given to each HA and LA preference. This way, we could calculate the mean attachment preference for each participant. Later on, following Kim and Christianson (2012), the mean attachment preference for each group was compared with .5, a hypothetical "no preference" mean, which would be attained if half of the items were scored 1 and the other half 0. It was reasoned that if the participants had no preference, their mean attachment preferences would not be significantly different from .5, and if HA informed their preference, their mean attachment preference would be significantly higher than .5, and if they opted for LA, their mean attachment preference would be significantly lower than .5.

WMC scores. The next step was to divide the participants based on their WMC scores. The participants were split into high and low WMC groups based on the mean of the WMC test. As can be seen in Table 1 below, a significant difference between the scores of high and low WMC participants was detected in monolinguals (t_{28} = 8.303; p = .000), L2ers taking the Persian task (t_{59} = 58.98; p = .000), and the L2ers taking the English task (t_{55} = 57.76; p = .000). Descriptive statistics and t-test results for the WMC are presented in Table 1.

Table 1

Descriptive statistics and independent samples t-test results for the WMC

	Monolinguals		L2ers Tested in Persian		L2ers Tested in English	
	High WMC N = 12	Low WMC N = 18	High WMC N = 33	Low WMC N = 28	High WMC N=34	Low WMC N = 23
Mean	.78	.55	.84	.63	.837	.625
(SD)	(.087)	(.068)	(.048)	(.003)	(.046)	(.077)
t-test results	$t_{28} = 8.303$;	p = .000	$t_{59} = 58.98$	; p = .000	$t_{55} = 57.76$	; p = .000

Analysis of the time data (online data). A comparison was made once between high WMC participants' HA and LA preferences online, and once between low WMC participants' HA and LA preferences. As can be gathered from Table 2 below, t-test results showed that there was no significant difference between the mean RTs of the participants with differing WMCs (both monolinguals in the Persian task and the L2ers in both English and Persian tasks) to say Yes to high attached or to low attached sentences (all Ps > .1). That is, the participants with differing WMCs did not perform differently from each other in each group while resolving RC ambiguity online. This could be due to the fact that they were under no pressure to give the answer. So they took their time and did not reply unless they were sure of their choices.

Table 2

The comparison of the RTs to HA and LA across different WMC levels

WMC	HA Mean	LA Mean	Paired samples t-test results	
(Monolinguals)				
Low	4760.74	4462.99	$t_{17} = 1.271$	p = .216
High	4180.42	4630.46	$t_{11} = 1.69$	p = .165
(L2ers in English)				
Low	4510.8	4383.82	$t_{32} = 0.525$	p = .604
High	4383.82	4443.37	$t_{27} = 0.096$	p = .924
(L2ers in Persian)				
Low	4643.48	4600.01	$t_{33} = 0.295$	p = .77
High	4276.99	4536.32	$t_{22} = 1.736$	p = .095

Analysis of attachment preferences (offline data)

Persian Monolinguals. The monolingual group's data from the PDT served as a baseline to be compared with the L2ers' performance in the Persian task to see if their preferences were influenced by their L2. No significant difference in the mean attachment preferences of the high (.62) and the low (.67) WMC monolinguals was identified ($t_{28} = 1.164$, p = .254, see Table 3 below), meaning that WMC did not affect the participants' preferences. Both groups had mean attachment preferences significantly higher than the hypothetical "no preference" mean, demonstrating a HA preference (see the last column in Table 3). This finding means that the monolinguals with differing WMCs did not perform differently when processing RC ambiguity offline.

L2ers taking the Persian PDT. The mean attachment preference scores of the high and low WMC groups were .34 and .52. The independent samples

t-test results (see Table 3 below) showed a significant difference between the two groups (t_{59} = 5.87; p = .000). The difference between the mean attachment preference of the high WMC group and the "no preference" mean was significant (t_{32}=7.46; p = .000), evincing that they preferred to attach RCs low. The difference between the low WMC mean attachment preference and the "no attachment" preference mean, however, was not significant (t_{27} = .793; p = .435), bearing out that they did not have any specific preference. Such behavior indicates that the L2ers with differing WMCs did perform differently while processing L1 RC ambiguity offline.

L2ers taking the English PDT. The mean attachment preference of those with high and low WMCs was .24 and .31. The last row in Table 3 below charts the difference between the mean attachment preferences of the two groups (not statistically significant, t_{55} =1.63; p =.109). For the high WMC group, the paired samples t- test results showed that the mean is significantly below .5 (t_{33} = 10.98; p = .000), indicating that they preferred to attach the RC low. The mean attachment preference of the low WMC group, too, was significantly less than the null preference mean (t_{22} = 4.893; p = .000). Thus, it can be concluded that both WMC groups have the same LA preference, pointing out that the L2ers with differing WMCs did not perform differently while processing L2 RC ambiguity offline.

Table 3

Comparison of high and low WMC participants in the monolingual and the L2er groups plus comparison of each group with the hypothetical "no preference" mean

		N	Mean attachment Preference	Paired Samples t-test Results*	Attachment Preferences
Monolinguals	High WMC	12	.62	t_{11}=3.362; p=.006	High
	Low WMC	18	.67	t_{17}=7.781; p=.000	High
	High and Low WMC compared	30		t28=1.16; p=.254	
L2ers in Persian	High WMC	33	.34	t_{32}=7.46; p = .000	Low
	Low WMC	28	.52	t_{27}=.793; p =.435	No preference
	High and Low WMC compared	61		t_{59}=5.87; p=.000	
L2ers in English	High WMC	34	.24	t_{33}=10.98; p=.001	Low
	Low WMC	23	.31	t_{22}=4.893; p=.000	Low
	High and Low WMC compared	57		t_{55}=1.63; p=.109	

* Paired samples t-test results show results comparing mean attachment preference scores of each WMC group with the hypothetical "no preference" mean.

6. Conclusion

In sum, this study found that L1 ambiguity resolution strategy of the advanced L2 speakers is different from their L1 counterparts and that their L1 and L2 ambiguity resolution carries traces of L2 (see also Kim & Christianson, 2016). That is, quite like what has been observed regarding the attrition of L1 linguistic features (e.g. Kasparian & Steinhauer, 2017; Tsimpli, Sorace, Heycock, & Filiaci, 2004), in this study, the L1 attrition of processing strategies is clearly detectable. This observation contributes to the evidence that L1 system is subject to alternation in face of recent preoccupation with L2. In English, though, L2ers' processing matched with their target-language natives, signifying that high linguistic proficiency has penetrated into their L2 processing.

Providing counterevidence to differing proposals on the permeability of the parser to forward transfer, and unattainability of native-like performance in L2 (Brysbaert & Mitchell, 1996; Gibson, Pearlmutter, Canseco-Gonzalez, & Hickok, 1996; Malakooti, 2010; Papadopoulou & Clahsen, 2003; Sasaki, 1994), this finding can be interpreted as a sounding support of the Tuning Account (Cuetos, Mitchell, & Corely, 1996). Even if L2ers' previous encounters with L2 ambiguity might not have been numerous enough to guide their parsing, due to their out-of-context language development, the mere fact of achieving a high level of L2 proficiency sufficed to equip them with the native-like L2 processing strategy and to bring about loss of their L1 processing strategy. That is, as a result of decrease of L1 use, L1 activation threshold goes up which results in the difficulty of its use. Then if the bilingual wishes to perform in L2, which has been more frequently used, the activation of the L2 items will incorporate not only those selected to be used at the moment, but also the

ones which have not been chosen (activation spreading). During this selection process, bilinguals would employ inhibitory control to hinder interference from other languages but not so much to obstruct comprehension (Paradis, 1993). Therefore, L1 attrition would emanate from increased use of L2, inhibiting competitors from L1, and engaging more of the language being processed than is required.

This claim, thus, emphasizes limitations of the cognitive system as it entails constraints (Frenck-Mestre, 2005). The existence of constraints, therefore, suggests that L1 use cannot be exempt from L2 interference. Things being so, inhibitory control must be exercised in order to hinder interference from the language not selected to be used (Green, 1998). Such control according to the Dynamic Model of Multilingualism doubles L1 maintenance effort (Herdina & Jessner, 2002) and repudiates the peaceful coexistence of languages in mind. Such anomaly can, however, be considered to have been settled in accordance with L2 owing to L2ers' recent preoccupation with English (Connectionist Framework, Grosjean, 1997).

Moreover, it was observed that high WMC L2ers chose an English-like attachment preference in their L1. L2ers' English preferences were also like English natives for both WMC groups. This result was obtained through a comparison between high and low WMC groups' preferences with the "no-preference" mean. Monolingual preferences were not under any significant influence of WMC. This finding seems to give credence to the *skill-through-experience* position (MacDonald & Christiansen, 2002), following monolinguals' having gained so much expertise in ambiguity resolution that their WMC was not called upon for better performance (Munakata, McClelland, Johnson, & Siegler, 1997; Roth, 1984). Owing to

their within-context language development, their chances to practice and improve the use of the specified structure have not been particularly slim like their bilingual counterparts in their L2 who were, thus, in need of WMC to aid parsing. What is behind this behavior can be the inherently more taxing nature of processing L2 input for memory resources than the processing of native language (Hopp, 2014). As mentioned above, only high WMC L2ers' parsing strategy in Persian (LA) patterned with those of the English native speakers (see also Dussias & Pinar, 2010; Kim & Christianson, 2016). We suggest that having attained a high level of proficiency in English, L2ers reached a point of uncertainty in their L1. The low WMC had no preference, indicating their being not sure as to what the right interpretation might be; the high WMC ones, though, seemed to have resolved this uncertainty as they chose an interpretation like English natives.

Corroborating the connectionist framework of MacDonald and Christiansen (2002) and rendering the attempt to separate capacity from knowledge pointless, the role of experience is, therefore, put on a spot light as those with greater experience with the structure (monolinguals) indicated a consistent preference and were not under the impact of WMC. However, the preferences of those with a limited experience (bilinguals) were modulated by WMC in L1, a reminiscent of the non-linguistic accounts of sentence processing (Gibson & Pearlmutter, 1998), implying the need to think twice when the talk of WMC role is brought up.

The results of this study provide strong support for the Experience-Based and Tuning accounts of sentence processing (Cuetos, Mitchell, & Corley, 1996), in that those individuals with their latest preoccupation with the learning and the teaching of English had their RC attachment preferences in line with the English natives' ambiguity resolution strategy.

Running counter to the tenets of Shallow Structure Hypothesis (Clahsen & Felser, 2006), which generalizes a less automatic and a less target-like processing behavior to L2 learners, the highly proficient bilinguals' processing preferences in this study accorded with their L2 native speakers' preferences. Such an observation provides evidence against the notion that L2 learners and even highly proficient ones fall short of attaining a native level competence in an L2 (Clahsen & Felser, 2006; Jiang, 2007). The instance of the attrition observed signifies that a peaceful coexistence of languages is almost impossible as the bilinguals' languages would be under the influence of each other (Dijkstra & Van Heuven, 2002).

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