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Ambiguity Resolution: Do Bilinguals Have an Edge Over Monolinguals?

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Abstract

Objective: This article provides a review of studies that have investigated the ambiguity resolution of bilingual comprehenders. It specifically examines whether bilingualism confers an advantage in resolving ambiguous sentences when compared to monolingualism.

Method: To conduct this review, peer-reviewed empirical studies on ambiguity resolution in bilingual and monolingual comprehenders were systematically examined. Relevant articles were identified through searches in academic databases (e.g., Scopus, Web of Science, PsycINFO) using keywords such as *bilingual ambiguity resolution*, *sentence processing*, and *conflict tasks*.

Results: The review findings indicate that bilinguals may show advantages in some ambiguity-resolution contexts; however, their performance is influenced by factors such as cross-language co-activation, language proficiency, and structural differences between languages. Evidence from linguistic ambiguity tasks does not consistently support a bilingual advantage, whereas findings from non-linguistic conflict tasks remain mixed. These inconsistencies appear to stem largely from methodological differences across studies.

Discussions: We suggest that, to examine ambiguity resolution in bilinguals and monolinguals, performance on linguistic and non-linguistic ambiguity resolution tasks needs to be

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differentiated; only highly proficient bilinguals might be able to resolve ambiguity in their L2 in the same way monolingual speakers do in their first language.

Keywords: Ambiguity resolution, bilinguals, monolinguals.

1. Introduction

As there is an overlap between the frontal brain regions involved in cognitive control of language and attentional and executive control, it is postulated that these shared processes can result in the better performance of bilinguals compared to their monolingual peers in the resolution of conflict tasks (Bellegarda & Macizo, 2021; Purmohammad, 2019). Recent studies indicate that becoming bilingual impacts individuals' cognitive system (Armstrong et al., 2019; Bialystok et al., 2006, but see von Bastian et al., 2016; Bellegarda & Macizo, 2021). Being bilingual has some effects inside and outside the language. For the inside language effects, for example, Bialystok (1988) reported that bilingual children outperform monolinguals at grammaticality judgment irrespective of the meaningfulness. In Galambos and Goldin-Meadow (1990), monolinguals and bilinguals were presented with different tasks assessing syntactic awareness, including detecting, correcting, and explaining errors. Results indicated a bilingual advantage for noticing and correcting errors for all the ages tested. Becoming bilingual has some effects beyond the language system, too (see van den Noort et al., 2019 for a systematic review). Vygotsky (1934) proposed that bilingual children should outperform their monolingual peers in solving Piaget's (1929) Sun-Moon problem[1] because words and their referents appear to be more detachable when an entity possesses two names. Later, researchers (e.g., Bialystok, 1988) reported that bilingual children solve the Sun-Moon problem more successfully than monolinguals. Thus, the idea of difference/s between bilinguals and monolinguals in comprehending ambiguous figures or ambiguous sentences comes from the general assumption that bilingual speakers outperform monolinguals on some linguistic and non-linguistic tasks, especially those tasks that require "disengaging from the first interpretation and reassigning the perceived features with their new meanings" (Bialystok & Shapero, 2005, p. 596).

Ambiguous words might cause difficulties in lexical processing. One of the main aims of studying ambiguity is to examine whether information at higher levels affects processing at the lexical level or whether lexical level processing is modular (Treiman et al., 2003). If there is an influence from the higher level on the lexical level, language comprehenders would have access only to the meaning that is contextually appropriate. If no influence from the higher level is postulated, it would be expected that all meanings of a given word are retrieved and after the initial processing of the meaning, context would have its influence (Treiman et al., 2003). Moreover, cross-language ambiguities have been exploited in several studies so as to demonstrate whether the non-target language is available when bilingual speakers tend to use only one of their languages. If they are able to ignore the non-target language effectively, their language performance in comprehending ambiguous words or structures should be the same as their performance in unambiguous conditions. To put it differently, bilinguals should perform the same as monolinguals in resolving ambiguity. However, if the other language cannot be inhibited, differences in linguistic performance between bilingual and monolingual speakers are expected (Dijkstra, 2005).

[1] In this task, children are asked to concede the arbitrariness of language labels by switching the names of objects, agreeing that if the sun were called the "moon" and conversely the moon were called the "sun", then the "sun" would be up at night and it would be dark (Friesen & Bialystok, 2012).

Ambiguous sentences are expected to cause difficulties in both monolingual and bilingual processing. Bilingual comprehenders might have more problems with ambiguity compared to their monolingual counterparts because semantic ambiguity exists both within and across the two languages. As for within-language ambiguity, in Persian, "Šir" has three meanings: "lion", "water tap," and "milk". Ambiguity also occurs across the two languages. An example is the word "angel" in English, which means "sting" in Dutch (Degani & Tokowicz, 2010). Therefore, a bilingual comprehender encounters both ambiguities that exist within a language and ambiguities that exist between the two languages. Dijkstra et al. (2000) asked participants to decide which language the words belonged to. They found that participants showed more difficulty with items such as "leek" that had another meaning in Dutch.

2. Method

To conduct this review, peer-reviewed empirical studies on ambiguity resolution in bilingual and monolingual comprehenders were systematically examined. Relevant articles were identified through searches in academic databases (e.g., Scopus, Web of Science, PsycINFO) using keywords such as *bilingual ambiguity resolution*, *sentence processing*, and *conflict tasks*. Only peer-reviewed empirical studies published in English were included in the review. Studies were selected if they examined ambiguity resolution in bilingual populations, compared bilingual and monolingual performance, or investigated factors influencing bilingual ambiguity processing. The review primarily focused on studies published between 1980 and 2023, while seminal earlier works were also included when relevant to theoretical development. Theoretical papers, dissertations, and studies unrelated to ambiguity resolution were excluded.

Studies that directly compared bilingual and monolingual participants or examined factors influencing bilingual ambiguity resolution were included. The selected studies were analyzed in terms of participants' language profiles, task types (linguistic vs. non-linguistic ambiguity), methodological differences, and reported outcomes.

Several factors might influence bilinguals' comprehension of ambiguous sentences. In this study, we review the underlying processes that are responsible for the bilinguals' advantage or disadvantage in resolving ambiguous sentences. A review of the various factors that might affect bilingual ambiguous resolution can shed more light on the issue of whether or not bilinguals have an advantage over their monolingual peers in resolving ambiguous sentences.

3. Co-activation of two languages

Ample evidence revealed that in bilinguals, the lexical and the syntactic representations of the two languages are co-activated nonselectively (Purmohammad et al., 2022; Purmohammad,2015a; 2015b). However, the extent to which the syntactic and lexical levels of representations interact during second language (L2) sentence processing remains unclear (Soares et al., 2019).

Processing ambiguous sentences may be more complex and challenging for bilingual speakers because they have another language in their cognitive system. Abundant studies (e.g., Hatzidaki

et al., 2011; Kroll, 2008) reported parallel activities of the two languages of a bilingual speaker. Studies on bilingual lexical access in sentence context (e.g., Schwartz & Kroll, 2006) also showed that the context may lead to constraints on cross-language activation; however, as the other language is activated to some extent, it does not permit complete language-selective access. In other words, the activation of the non-target language affects lexical processing in the target language. Slips of the tongue revealed cross-language semantic substitution, and blends are more likely to make phonological errors when the resulting error is a lexical item from the non-intended language compared to when it is a nonword (Hatzidaki et al., 2011).

Research on monolingual language processing reports that when a monolingual comprehender faces a homograph (words that have identical lexical form but not identical meanings, for example, cool in English), all the meanings of the homograph item are activated, but the comprehender resolves the ambiguity very quickly and keeps active only the meaning that is most appropriate for the text. As Swanson (2010) states, most data from interlingual homographs [e.g., red means net or web in Spanish] are in line with monolingual findings for a nonselective access account in which both language meanings are simultaneously and automatically activated, as long as the tasks include both languages. Studies (e.g., Kilborn, 1989; McDonald, 1987; MacWhinney, 1997) demonstrated that as the other language is active, it influences sentence comprehension in the L2. Experience-based models such as the Competition Model proposed in MacWhinney (1997), assume that non-native speakers transfer the processing strategies from their first language to their L2, before they gradually become more native-like in their L2 language as the components of the other language are internalized. Thus, the processing strategies developed in bilinguals' first language influence their sentence analysis in L2 (see Bates & MacWhinney, 1982, for a completion model account and Durgunoglu & Hancin, 1992, for extensive reviews).

Then, if we propose that the two components of a bilingual comprehender are active during sentence comprehension, we might expect that bilinguals experience more ambiguity than monolingual speakers in their language comprehension. For example, in reading a sentence containing the word "angle", an English monolingual does not encounter ambiguity, but a Dutch-English bilingual comprehender experiences an ambiguous condition. So one of the differences between the two groups of comprehenders lies in the number of ambiguous conditions that they encounter in their language comprehension. To put it differently, with respect to resolving ambiguous sentences, bilinguals differ from their monolingual counterparts quantitatively.

Schwartz et al. (2009) investigated whether cross-language activation has any effects on English–Spanish bilinguals' L2 disambiguation processes. The researchers conducted two experiments. In Experiment 1, Spanish-English bilinguals were asked to read English sentences biasing the subordinate meaning of homonyms. The meanings were either cognates or non-cognates. The subjects' ability to reject incoming words related to the dominant meaning revealed the strongest inhibition when the homonym was a cognate and the dominant meaning was with the same meaning in Spanish. In Experiment 2, the subjects read sentences biasing the dominant meaning of the homonyms. They were required to accept target words related to any meaning of the homonym. In this case, it was expected that the cognate condition of the homonym facilitated acceptance of targets related to the subordinate meaning when this was

identical in Spanish. The researchers (2009) reported that the existing cross-language activation in bilingual language processing has a crucial influence on the time-course. In other words, cross-language activation has a critical effect on the time-course in which a meaning is activated in bilingual comprehenders. The results showed that "there was boosted competition from the co-activated dominant meaning of ambiguous cognate prime words (e.g., novel)"(Schwartz et al., 2009, p. 37). The researchers concluded that access to the two meanings of biased, ambiguous prime words is non-selective in bilinguals.

Andrew et al. (2020) investigated the processing of multiple ambiguity types. They examined whether differences in structure type affect recognition frequency and resolution choice. They used offline questionnaires containing 40 sentences: 20 ambiguous and 20 unambiguous. Target stimuli included 2 types of local ambiguity and 6 types of global ambiguity. Subjects were L1 Arabic–English bilinguals and English monolinguals. Bilinguals completed both experiments in Arabic and English to test for their L1 influence upon L2 processing. The results showed that clause length ambiguities were recognized more frequently than relative clause attachment. Local ambiguity was recognized more frequently than global ambiguity in both bilinguals' languages. Experiment 2 revealed that bilinguals preferred resolution choices with high attachment and long clauses modifying short clauses, even when ambiguity type and input language were varied. Moreover, L1 exerts a significant influence on L2 parsing decisions. Bilinguals' Arabic grammar had strong effects on their ambiguity resolution decisions in both languages. Bilinguals' L1 (Arabic) grammar biased them toward long noun phrases.

Headedness and verb movement parameters are different in German and English. While VP and IP in German are head-final, English is head-initial. Rankin et al. (2016) used a picture interpretation task to study whether co-activation of L1 syntax can affect transfer during L2 sentence comprehension by investigating how German native speakers process number agreement in English wh-questions. They used a comprehension task. The results showed that the grammar of German is co-activated as participants parsed English wh-questions. Comprehension patterns were consistent with the German grammar 'rescuing' a parse of ungrammatical English clauses.

Since bilinguals are not generally able to access a single lexicon selectively, and given that both lexicons corresponding to the two languages are activated even in monolingual tasks (Beauvillain & Grainger, 1987; Cristoffanini et al., 1986), the lexical information from speakers' native language might even become available more quickly than that from the second language as a function of frequencies of the items and/or the level of language proficiency of bilingual speakers (Frenck-Mestre,1993). Given the above finding, Frenck-Mestre and Pynte (1997) contend that the non-native parser may, at least momentarily, adhere to rules from his or her native language when the first and second languages exhibit conflicting syntactic and lexical information. For example, such a conflicting situation may occur in analysing the sentence, such as *Every time the dog obeyed, the pretty little girl showed her approval* (p.136), where the verb "obey" might be processed as both a transitive or an intransitive verb.

4. Bilingual cognitive processes

A long-lasting debate in bilingualism studies is whether learning two languages yields benefits to cognition (Nichols et al., 2020). As the effect of bilingualism is a controversial issue, some researchers (e.g., Paap et al., 2015) questioned applying the term “bilingual advantage” and prefer to use a more neutral term “bilingual effect” instead.

Bilinguals constantly encounter conflict between competing language representations at the lemma level and practice switching between L1 and L2. These tasks often involve domain-general executive function networks because any competition is required to be solved by inhibiting active, non-target stimuli (Lehtonen et al., 2018). This continued practice in dealing with between-language competition leads to the transfer of the abilities to other cognitive domains (Bonfieni et al., 2019, but see Nichols et al., 2020). Recently, many studies focused on executive functions, i.e., the cognitive processes that are engaged in planning, managing, and executing goals.

Much research has been done in order to find the effect of bilingual cognitive processes on resolving ambiguous sentences (Derakhshan et al., 2021). Blumenfeld and Marian (2011) state that a link between linguistic performance and cognitive control abilities has been established across a range of language processing contexts” (p. 245). Many recent studies (e.g., Poort et al., 2016) attribute the considerable difference between bilinguals and monolinguals in comprehending ambiguous figures or sentences to the processing mechanisms. For instance, Bialystok and Shapero (2005, p. 596) assume that “at least part of the ability to reinterpret an ambiguous figure may be under the control of the executive processes of selective attention and inhibitory control”.

Chung-Fat-Yim et al. (2016) compared bilinguals and their ability to see the alternative image in an ambiguous figure. This ability is tied to selective attention. They used a novel ambiguous figures task in which an unambiguous image is presented that gradually transformed into a different image through manipulating the features with each card. These features, thus, functioned as primes by providing the context of the alternative image. Bilinguals outperformed their monolingual peers by requiring fewer cues to identify the second image.

Sorge et al. (2016) compared 8 to 11-year-old bilingual and monolingual children for their ability in attention control. Both groups performed 3 tasks that required aspects of executive functioning: stop signal task (inhibition), flanker task (interference control), and frogs matrices task (spatial working memory). The authors reported that both bilingualism and attention ability contributed to performance on the executive functioning tasks. Where interaction effects were significant, they indicated that bilingualism was a stronger predictor for performing an interference task (flanker task).

Bialystok and Shapero (2005) conducted two experiments to examine whether the bilinguals’ benefits in executive processing are extendable to their abilities to reverse between the interpretations of ambiguous figures and two content-meaning figures. They found that bilingual children had more remarkable achievements than monolinguals in seeing the other meaning in the images because both the card sort task and the ambiguous figures task need “executive control over the ability to attend selectively to aspects of a stimulus and resolve conflict from competing responses (p. 603). Bilinguals are more developed in performing these processes, and

they outperform in seeing the alternative images. The researchers add that bilingual children are faster in doing the tasks that subject "must selectively attend to one aspect of a stimulus when attention is more habitually drawn to competing elements" (p. 596). According to these predictions, bilinguals are expected to outperform monolinguals in comprehending ambiguous sentences because the tasks require selective attention and inhibitory control. Accordingly, as understanding ambiguous sentences requires that bilinguals limit access to one of the values and simultaneously enhance attention to the other, we may speculate that bilinguals understand ambiguity better than monolinguals.

A second reason that bilingual comprehenders may perform better than monolinguals on ambiguous sentence comprehension or in general in ambiguous conditions is that in their everyday use of language, bilingual speakers frequently encounter many objects that have two different linguistic representations. This specific linguistic experience, which is a sort of metalinguistic awareness, may have provided the bilinguals with an understanding of metarepresentation that an individual object may be represented differently by different people (Goetz, 2003). This metalinguistic awareness helps bilingual speakers to develop their theory of mind ability. Theory of mind concerns the abilities that enable us to realize that others have beliefs, information, plans, hopes, desires, and intentions that may be different from our own (Korkmaz, 2011). Having developed a theory of mind (ToM), bilingual speakers may better understand people's intentions, desires and beliefs than monolinguals. Bilinguals tend to show a greater tolerance for ambiguity because they have more experience with situations in which a message may have multiple meanings. In fact, "tolerance of ambiguity is a beneficial feature of divergent thinking, as irrelevant, often contradicting elements, coexist during this process" (Lubart, 1999, p. 344).

Contrary to the so-called advantage of bilinguals over monolinguals in comprehending ambiguous sentences due to their more developed ToM abilities and more developed controlled attention, we might expect that better inhibitory control abilities of bilinguals may also lead to a disadvantage in their processing especially in comprehending ambiguous sentences, because more executive control is engaged when language processing demands are high, for example, in comprehending ambiguous sentence (Blumenfeld & Marian, 2011). For this reason, we should expect more processing tax. According to the above prediction, while we can expect bilingual speakers to understand ambiguous sentences better than monolinguals, they may be slower than monolinguals. To comprehend an ambiguous sentence, a certain processing cost may be increased in bilingual speakers because of the additional inhibitory and control mechanisms of language A that are occurring alongside the routine processing of language B. (Sorace et al., 2009). In other words, it is cognitively more costly for bilingual speakers to inhibit the other language to which the non-target meaning of an ambiguous word belongs. Hahne (2001) used the event-related brain potentials (ERPs) in order to compare semantic and syntactic processing between German native speakers and proficient learners of German who were native speakers of Russian. The researcher reported that the semantic incongruities processing between native and non-native speakers was only quantitatively different, but it was found that the two groups of speakers processed the syntax of the sentences qualitatively differently. The researcher concluded that the non- native speakers process the phrase structure differently from the native listeners. Syntactic processes resulted in language processing of the two groups to be both

quantitatively and qualitatively different. The same results were also reported in Díaz et al.'s (2016) study. Moreover, Hahne (2001) reports that although bilinguals process semantics and syntax the same way that monolinguals, the differences arise as bilinguals process them more slowly than monolinguals. The researcher interpreted the different patterns in terms of different amounts of automaticity with regard to the subprocesses engaged in sentence comprehension.

In Cook (1990), native speakers of English and advanced Japanese users of English were asked to find the antecedent for the pronoun him in sentences like John said Peter helped him. While bilingual and monolingual native speakers scored almost the same (93% and 92% respectively) in finding the correct antecedent, their timing differed considerably (7.6 seconds and 4.6 seconds respectively). This study shows that while advanced Japanese users did not have problems in binding relationships, they needed considerably more time to do the comprehension task.

This additional operation may lead bilingual speakers to prevent unwanted interference from the non-target language meanings in ambiguous sentence comprehension but they may need more time to resolve ambiguity. Sorace et al. (2009, p. 474) believe that "better inhibitory control abilities of bilinguals can be an advantage in some aspects, but also a disadvantage in other aspects".

Oiler and Tullius (1973) investigated the eye movements of native English readers and non-native English readers. They found that by comparison with native comprehenders, non-native comprehenders had fixated for a longer duration. The difference in the fixation time indicates that non-native comprehenders need more time to process the information. The same result was also reported by Favreau and Segalowitz (1983). The researchers assume that the result is due to the fact that bilingual comprehenders rely more on their attentional and controlled mechanisms than on automatic processes to comprehend their second language. Thus, it might be the case that bilinguals are faster in doing the non-linguistic tasks in which they "must selectively attend to one aspect of a stimulus when attention is more habitually drawn to competing elements" (Bialystok & Shapero, 2005, p. 596). However, they might be slower in doing the linguistic tasks that require the same mechanisms as well. Bilinguals may also be slower because the disambiguation process is affected by some other factors, such as language proficiency, transfer from L1 to L2, and the way around, etc.

5. The cognate effects

Several studies (e.g., Costa et al., 2000) show that bilingual speakers produce and comprehend cognates much faster than non-cognate words. However, cognate words have two opposing effects on bilingual language comprehension. In some cases, the meanings of a cognate word across the two languages of a bilingual comprehender remain the same. Those cross-language cognates whose meanings overlap to a great degree or completely make bilingual language processing easier or faster. For example, Duyck et al. (2007) report shorter reading time for cognate words, a phenomenon known as the cognate facilitation effect. Cognate facilitative effect was reported in several studies (e.g., Dijkstra & van Hell, 2003; van Hell & Dijkstra, 2002). However, sometimes the meanings of cognate words change in one of the two languages in the course of time. Such changes in the meaning of cross-language cognate words create ambiguous

conditions for bilingual comprehenders. When a bilingual comprehender encounters such cognate words, their semantic representation from the non-source language is activated. A bilingual comprehender has to decide which meaning to choose that is most appropriate for the given context. For example, "avertissement" in French (a false cognate of English advertisement) means “warning" or "caution". As Fontes et al. (2009) state, when there is no complete lexical overlap, these effects disappear or turn into inhibition. Monolingual comprehenders do not experience such ambiguous conditions in their language comprehension. In their Experiment 1, Schwartz et al. (2009, p. 37) report that when bilinguals encounter ambiguous L2 words that are cognates with the first language, co-activation of the first language representation would affect the time-course and strength with which each individual meaning would be activated. Cognate words influence language processing in the native language as well. Assche et al. (2009) examined whether L2 can affect reading in L1 reading. The results revealed that a cognate effect exists in the processing of the native language. The results also indicated that a second language influences reading in the native language.

The cognate effect (whether there is a full or partial overlap) also indicates that the non-target language is activated during language comprehension. Assche et al. (2009, p. 926) propose that the presentation of a word in one language activates information on phonological, orthographic, and semantic representations of all languages. The cross-language activation, which spreads from these codes, speeds up the activation of cognate words compared to control words and this leads to faster word-recognition times.

Thus, what might be conceived from the cross-language cognate studies (e.g., Dijkstra et al., 1999; Duyck, 2005) is that both languages of a bilingual speaker are activated during language comprehension. Kroll)2008) adds, “when form and meaning converge across the two languages, bilinguals’ performance is generally facilitated; but when form and meaning conflict, their performance is typically hindered, in that it is slower and they are more likely to experience error.

Casaponsa et al. (2015) examined how the degree of reliance on cross-language similarity (as measured by the cognate facilitation effect) contributes to reading comprehension achievement in a non-native language. Native speakers of Spanish learning English at elementary and intermediate levels participated in this study. Participants completed three tasks, including a lexical decision task, a working memory task using the forward number retention task, and the Kaufman Brief Intelligence Test to measure their non-verbal intelligence. A set of 200 English nouns was used for the lexical decision task. Half of the items were Spanish-English cognates, and the other half were non-cognates. They reported that individual differences in the degree of reliance on native language predicted subjects’ L2 reading achievement. The cognate facilitation effect was observed to be positively related to reading achievement at initial stages of the learning process, however, at intermediate levels of L2 learning, this relation turned to be negative. Casaponsa et al. (2015) concluded that the link between native-and non-native language lexical representations helps subjects at lower levels of proficiency; however, the effect was not observed at intermediate levels of proficiency, when reliance on cross-language similarity is inversely related to successful L2 reading achievement. Thus, at intermediate levels of proficiency, strong and direct links from the L2 lemma node to conceptual nodes are required to achieve L2 reading comprehension.

6. The effect of language proficiency

It is not surprising to assume that bilinguals' language proficiency is a key factor that determines whether they might have an advantage or disadvantage in resolving ambiguous sentences compared to monolingual speakers. Studies (e.g., Frenck-Mestre & Prince, 1997) showed that highly proficient bilinguals are able to activate different meanings of ambiguous words very quickly the same way as native speakers. Language proficiency has a critical role in the way a bilingual speaker disambiguates ambiguous sentences. This idea can be explained in terms of experience-based accounts (Mitchell et al., 1995) that the frequency of people's exposure to a specific language input impacts the parsing process (Papadopoulou, 2005). To put it differently, the more a speaker is exposed to the ambiguous sentences in a given language, the more likely he will be able to resolve the ambiguity. Language proficiency is among the major factors that seem to influence the way in which a sentence context provides constraints on cross-language activation. Studies (e.g. Elston-Güttler et al., 2005; Schwartz & Kroll, 2006) showed that only highly proficient speakers are more prone to adapt language-selective patterns. Elston-Güttler et al. (2005) reported three semantic priming lexical decision experiments in which reaction time (RT)/event-related brain potential (ERP) were used. They investigated to what extent language proficiency, sentence context, and the locus of L1 activations affect the activation of L1 during the processing of L2. The researchers reported that with respect to the translational activation, cognitive control is modulated by speakers' language proficiency, because the results showed that the early interference in the N200 was reported only for low-proficiency learners.

It should be noted that there are two major classes of models with respect to disambiguating ambiguous materials. In the garden-path model proposed in Frazier (1987) and Frazier and Fodor (1978), analysis is purely based on syntactic information (e.g., phrase-structure rules) at least at the initial stage of sentence processing. If the initial syntactic-based analysis is not successful, reanalysis occurs based on non-syntactic information (e.g., the thematic processor). Nevertheless, the interactive or constraint satisfaction models of sentence processing (e.g., Thornton et al., 1999) postulate parallel processing so that all types of information (e.g., words' argument structure, semantics …) available to the parser are considered and influence even at the initial analysis of ambiguous sentences (MacDonald et al., 1994). Some questions with respect to bilinguals' ambiguity resolution are what strategies bilinguals adapt in order to resolve ambiguity, and whether or not there is any correlation between their parsing decision and their language proficiency. A third question is to what extent bilinguals consider non-syntactic information for disambiguating ambiguous materials. Felser et al. (2003) examined the way native English-speaking children and advanced L2 learners of English resolve relative clause (RC) attachment ambiguity. The researchers report that while native speakers rely on structure-based parsing principles, L2 learners primarily rely on non-structural information (lexical-semantic information). Thus, the results suggest that the strategy that a bilingual adapts in order to analyse RC attachment ambiguity highly depends on her level of language proficiency.

Soares et al. (2019) used eye-tracking technique to investigate how the syntactic and lexical levels of processing interact during sentence processing in L2 and how the lexical and syntactic interactions were modulated by speakers' L2 proficiency. Native-speakers of European

Portuguese (EP) learning English at mid and high levels of proficiency were instructed to silently read ambiguous L2 relative clause (RC) sentences disambiguated with a High-Attachment (HA) or Low-Attachment (LA) strategy while their eye-movements were recorded. Since European Portuguese and English native speakers process and comprehend this type of syntactic structure differently (EP prefer HA, and English prefer LA), HA preferences were used as a marker of L1 RC syntax interference. Moreover, the researchers manipulated the cognate status of the complex NP that preceded the RC in order to examine how the lexical co-activation of the two languages would also influence the syntactic representations of the non-intended (L1) language. Results revealed cognate facilitation effect in early and late reading time measures regardless of level of proficiency in L2, and also that the cognate status of the complex NP affected L2 reading, particularly in low proficient bilinguals. These findings also suggested that, with an increase in L2 proficiency, L1 RC syntax interference becomes stronger, in a syntactic parser that operates in a more integrated and nonselective way.

Dussias and Piñar (2008) argue that the effect of language proficiency on sentence comprehension in L2, however, varies depending on the type of information (syntactic, semantic) that is processed. The results of several studies (e.g., Hahne, 2001; Kotz & Elston-Guttler, 2004) revealed that the semantic processing of a sentence is not considerably affected by differences in language proficiency. However, the level of language proficiency significantly affects processing of other information, especially the syntactic information, "with only proficient learners resembling native speakers" (Dussias & Piñar, 2008, p.302). For example, in Frenck-Mestre's (2002) study, only proficient L2 speakers resolved ambiguity the same way as native speakers.

In Dussias and Sagarra (2007), both Spanish monolinguals and Spanish-English bilinguals with limited or extensive immersion experiences in their L2 environment were presented with ambiguous sentences including a relative clause preceded by a complex noun clause (NP) in Spanish as their dominant language. They reported that the bilingual speakers who had limited immersion experience in the L2 environment parsed the ambiguity by employing the same strategies as Spanish monolinguals did. Contrary to this group of bilinguals, the Spanish-English speakers who had extensive exposure to English, as their second language, resolved ambiguous sentences using strategies associated with their L2, English.

Dussias (2003) examined whether highly proficient speakers of English and Spanish use the same or different parsing strategies as their monolingual peers when they read ambiguous sentences such as "Peter fell in love with the daughter of the psychologist who studied in California" (Dussias, 2003, p.532). This sentence contains an RC preceded by a complex noun phrase. She found that both highly proficient speakers of L2 have a strong preference for local attachment rather than nonlocal attachment. With respect to the Spanish-English participants' preference to NP2 attachment, Dussias (2003) assumes that, as the Spanish-English speakers had lived in an English language environment for at least eight years, their linguistic performance may be because they were exposed to many English ambiguous conditions that resolved in low or local attachment. Their linguistic experience "may have rendered this interpretation more available, ultimately resulting in the preference for NP2 attachment" (Dussias & Piñar, 2009, p.18).

Some studies (e.g., Felser et al., 2003; Frenck-Mestre, 2000) showed that the level of language proficiency influences the attachment preference in ambiguous sentences. For example, highly proficient speakers express preference for Np1 in sentences such as "*the teacher called the father of the student who lives in Zurich*". The results indicated that consistent exposure to the L2 input might lead to the adoption of a parsing mechanism similar to native speakers' strategy in ambiguity resolution. These findings indicate that the extent to which L2 speakers are able to use different sources of information during L2 sentence comprehension is a factor of their level of proficiency (Dussias & Piñar, 2008).

Lastly, ERPs also presented evidence that even late L2 learners develop sentence processing abilities with increasing L2 exposure and despite a late age of acquisition, they can achieve native-like processing with high proficiency. While the learning trajectory appears to be primarily affected by proficiency, it may also differ based on other factors such as type of training, the particular structure investigated, individual variability, or typological distance between the first and second languages (Traxler et al., 2018).

7. Language similarity

As the two meanings of interlingual homographs (e.g., "leek", which means "layperson" in Dutch) cross the language boundary, it seems that language similarity is also important to some extent (Degani &Tokowicz, 2010). Languages with the same script permit "cross-language pairs to share both orthography and phonology" (p. 1280); cross-language form similarity for languages that use different scripts is limited to phonology only. Some studies (e.g., Dean & Valdés Kroff, 2017; Dijkstra et al., 1999) showed that the similarity in both the phonology and orthography affects the processing of cross-language ambiguity. Thus, while the absence of a shared script might affect the ambiguous sentence processing of bilingual speakers, monolinguals' processing of ambiguity is not affected by such a variable.

Erdocia and Laka (2018) examined whether the L1 word order affects the processing of non-canonical but grammatical sentences in L2 comprehension and whether L1-Spanish speakers of L2-Basque process subject–verb–object (SVO) and object–verb–subject (OVS) non-canonical word order in Basque the same as native speakers of Basque. OVS orders are non-canonical word orders in both languages; however, the SVO word order is non-canonical in Basque but is canonical in Spanish. The electrophysiological results revealed that the L1 features affect the processing of the L2 sentences even in highly proficient and early acquired bilinguals. In the non-native group, they reported a left anterior negativity-like component when comparing subject (S) and object (O) at sentence initial position and a P600 when comparing S and O at sentence final position.

One of the challenging situations for non-native comprehenders is that they need to parse sentences the same way as native speakers do. Problems might occur when the parsing process in L1 and L2 diverges. Moreover, studies (see Cuetos et al. 1996 for review) showed that speakers of a particular language might have different preferences for RC attachment (e.g., *The boy saw the father of the teacher who was having a black hat*). As an L2 speaker might adapt language parsing that is specific to his L1, this situation leads to a problem in interpreting the sentences,

especially the ambiguous sentences(Kroll & Dussias, 2004). For example, speakers of English, Swedish, and Arabic prefer to attach the RC to the NP2; however, French, German, and Spanish speakers prefer NP1 attachment. Such different RC attachment preferences across languages may cause problems for bilingual speakers when resolving ambiguity. Previous bilingual studies (see Yeh, 2011, for an extensive discussion) showed that, for example, monolingual Spanish and English speakers differ in how they prefer to resolve this type of ambiguity. Spanish speakers prefer to resolve the ambiguity by attaching RC to the first noun and English speakers prefer to attach it to the second noun in a sentence such as "*The robber shot the secretary of my husband, who goes to work on weekends*" (Yeh, 2011, p. vi). Then, speakers of different languages may express different disambiguation preferences. Rah and Adone (2008) also reported that L2 learners transfer attachment preferences from their L1 to their L2; however, these effects decrease as language proficiency increases. Moreover, such cross-linguistic variation for NP attachment preference indicates that bilinguals might be expected to face more difficulties resolving ambiguity in their L2 than monolinguals. The degree of structural similarity between L1 and L2 is also considered a key factor in transferring the L1 structures and, hence the degree of difficulty of second language sentence processing (Flynn, 1989). Bilinguals were reported to make considerably more grammatical errors on sentences that favor the syntax of their first language than do their monolingual peers (Frenck-Mestre & Pynte, 1997).

8. Discussion

Researchers have used cross-language ambiguities in order to investigate how bilingual speakers are affected by the presence of the ambiguity when they intend to understand those ambiguous items in only the intended language. This study reviewed some factors that affect bilingual resolution of ambiguous sentences. As the studies reviewed suggest, several linguistic and non-linguistic factors affect bilingual language comprehension. Recent research (e.g., Blumenfeld & Marian, 2011) speculates that bilingualism enhances cognitive control functions in resolving ambiguous sentences because the parallel activation of languages necessitates control of language interference. Accordingly, as bilinguals have more developed selective attention, control mechanisms, and also theory of mind abilities, they outperform monolinguals in resolving ambiguity overall.

The co-activation of the two languages of bilinguals during sentence comprehension, especially in ambiguous sentence conditions, might cause language processing to be more difficult for bilinguals than monolinguals because a mechanism is required to inhibit the non-target language. We also assume that the co-activation of both languages may increase processing demands during ambiguity resolution, particularly when inhibition of non-target representations is required. This assumption is supported by the fact that interference also occurs from L2 to L1. Since both language of a bilingual comprehender is activated, we expect that bilingual comprehenders encounter more ambiguous conditions than monolinguals in their language comprehension. Thus, with respect to resolving ambiguous sentences, bilinguals are also quantitatively different.

As Frenck-Mestre and Pynte (1997) proposed, the difficulty associated with reading in non-native languages was reported in various studies of sentence processing using various techniques such as reaction time (Mack, 1986), ERP (Elston-Güttler et al., 2005), and assignment of grammatical roles (Kilborn, 1989). These studies revealed that there are two differences between sentence processing in L1 and in L2. First, second-language processing often requires greater processing resources than native-language processing. Second, the pattern of analysing sentences in a second language may differ qualitatively from native-language processing. Both of these main difficulties are considered bilingual disadvantages in the processing of ambiguous sentences in the second language.

Note, however, that according to Barto-Sisamout (2009), the results of the studies that examined whether the differences in attachment preferences in the two languages affect the online L2 comprehension seem to be mixed. Some studies revealed evidence for the L1 transfer in less proficient speakers (Frenck-Mestre, 2002), others indicated convergence on L1 attachment preferences for highly proficient bilinguals (Frenck-Mestre, 2002), (although these two results do not necessarily conflict), while others reported no attachment preference in the L2 (Felser et al., 2003). Moreover, Desmet and Declercq (2006) reported that not only can the syntax of L1 influence the syntax of L2 (see Desmet & Declercq, 2006 for a similar result), but also that L2 can interfere with the L1.

With respect to whether bilinguals have an advantage over monolinguals in resolving linguistic ambiguity, we assume that a bilingual should not only be considered as a speaker who has more developed selective attention and control mechanisms than their monolingual counterpart, because various factors affect speakers' performance in resolving ambiguous sentences. As Bialystok and Shapero (2005, p. 596) suggested, only "part of the ability to reinterpret an ambiguous figure may be under the control of the executive processes of selective attention and inhibitory control". The other factors also play critical roles in linguistic tasks that require resolving. For example Gibson and Pearlmutter's (1994) multiple-constraint model of sentence processing, suggest that NP attachment preferences in sentences such as "someone shot the servant of the actress who was on the balcony" are determined by the strength of different interacting structural and non-structural factors (Felser et al., 2003) and, as they observed, not only by speakers' cognitive ability to see the alternative meanings. Thus, bilingual cognitive process is actually one factor among the various factors that affect their performance in resolving ambiguity. Since more variables affect bilingual linguistic ambiguity resolution than monolinguals, as the researchers put it, even highly proficient L2 speakers do not process ambiguous sentences in quite the same way as native speakers do, at least to the extent that "their use of structure-based parsing strategies is concerned" (p. 466). Moreover, the results of the studies revealed ample evidence of the claim that bilingual linguistic performance is influenced by the non-target language.

As reviewed in this essay, bilingual comprehenders have both advantages and disadvantages over monolinguals in processing ambiguous sentences. Bilingual performance in linguistic tasks that require resolving is affected by many variables that might not be present in the performance of their monolingual counterparts. However, advantages observed in non-linguistic executive-control tasks do not necessarily translate to linguistic ambiguity-resolution tasks, which are

influenced by additional language-specific factors. Thus, we suggest that, to examine ambiguity resolution in bilinguals and monolinguals, performance on linguistic and non-linguistic ambiguity resolution tasks needs to be differentiated.

Our conclusion is in line with the results reported in Giovannoli et al.'s (2020) study. They reviewed 53 studies that investigated the relationship between bilingualism and executive functions. They also found that bilingualism may not affect all aspects of cognitive functioning. Their review revealed that the bilingual effect is observed when inhibition and cognitive flexibility are assessed; however, this effect is not observed when working memory is considered.

Considering the heterogeneous results reported in the studies examined in this review article, it seems that further research is necessary in this domain in order to get a better understanding of the mechanisms that underlie the resolution of ambiguous sentences in bilingual speakers.

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