The interpreter advantage hypothesis

Preliminary data patterns and empirically motivated questions

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The 'interpreter advantage hypothesis' posits that task-specific cognitive skills developed by professional interpreters (PIs) generalize to more efficient linguistic and executive abilities in non-interpreting tasks. This paper reviews relevant studies in order to establish preliminary data patterns and outline new research questions. Though not entirely consistent, the evidence suggests that interpreting expertise enhances aspects of semantic processing, working memory, and cognitive flexibility. The data also gives rise to new related queries: Are linguistic and executive enhancements in PIs independent of each other? Are all the superior skills of PIs cumulatively enhanced by the double influence of bilingualism and interpreting experience? And how soon after the onset of formal training do these advantages appear? Tentative answers to these questions are also implied in the evidence considered.

Keywords: bilingualism, interpreting, expertise, linguistic processing, executive functions

1. Introduction

In the psycholinguistics and neurolinguistics literature, the term 'bilingual' encompasses all individuals who use two different languages in everyday life (Grosjean 1994) and can choose to communicate in either language depending on the circumstances (Paradis 1984). Recent studies have shown that the acquisition and sustained use of a non-native language (L2) influences multiple cognitive domains. Compared to monolinguals (MLs), bilinguals demonstrate greater rates of tip-of-the-tongue states (Gollan and Acenas 2004), reduced vocabulary fluency (Bialystok et al. 2010), and slower response times in object-naming tasks (Kaushanskaya and Marian 2007). However, there is abundant evidence supporting

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the 'bilingual advantage hypothesis,' which posits that the cognitive skills developed to represent and control two languages generalize to enhanced processing in several domains, such as selective attention, problem-solving, and metalinguistic awareness (for reviews, see Bialystok 2001, 2011; Bialystok et al. 2009).

Yet, not all bilinguals have identical cognitive profiles. For example, L2 grammatical processing may rely on different memory systems depending on the age at which the language was acquired (Paradis 2009; Ullman 2001). Also, the level of L2 proficiency modulates translation asymmetries and differences in conceptual involvement between L1 and L2 tasks (Guasch et al. 2008; Talamas et al. 1999). Further distinctions can be made as to *how* bilinguals use their linguistic and related cognitive systems. For instance, when bilinguals interact with monolingual speakers of their L1 or their L2, such that only one language is used, communication occurs in a 'monolingual speech mode.' On the other hand, when verbal interaction takes place between two bilinguals sharing both languages, so that these can be switched and mixed at will, they are in the 'bilingual speech mode' (Grosjean 2001).

A third speech mode, which may be termed 'interpreting speech mode,' is distinctive of a specific group of bilinguals: professional simultaneous interpreters (PIs, García 2012).[1] Unlike non-interpreters, PIs daily face communicative situations in which: (a) they interact with an interlocutor who knows their L1 but not their L2, and another one who knows their L2 but not their L1; (b) ongoing source language (SL) input must be processed at the same time that previous instances of input are being translated and articulated as target language (TL) output; (c) production of the output message must take place only in the TL, through inhibition of competing representations in the other language; and (d) code-mixing must be deliberately prevented (García 2012; see also Chernov 1994; Grosjean 2001; Paradis 1994).[2]

In the case of simultaneous interpretation, these processes often take place at a rate of roughly 120 words per minute (Gerver 1975), with ear-voice spans ranging from either 2 to 10 seconds or 2 to 8 words (Christoffels and de Groot 2003; Oléron and Nanpon 1964). Chernov (1994) has estimated that in professional settings, simultaneous interpreters spend 70% of the time concurrently processing SL input and TL output, which taxes attentional and language control mechanisms. In addition, interpreting requires full attention to compensatory inferencing

1. The acronym PI will be used throughout the remainder of this article to refer specifically to interpreters who systematically engage in simultaneous interpreting.

2. Note that PIs may also work using other modes, such as consecutive interpreting or sight translation. However, the PIs tested in the studies presently discussed were all experts in simultaneous interpreting and developed their careers around this mode.

strategies. Despite these demands, propositional correspondence between SL input and TL output in professional simultaneous interpreting can reach means of approximately 70% (Barik 1975; Gerver 1975).

Thus, as compared to non-interpreter bilinguals (NIBs), PIs are subject to more stringent linguistic and executive demands, the latter including skills such as working memory (WM) use, attentional allocation, inhibitory control, and cognitive flexibility (Zillmer and Spiers 2001). So, if the 'bilingual advantage hypothesis' is correct and increased control demands during linguistic processing result in cognitive enhancements, then PIs may be "doubly advantaged," insofar as the executive demands associated with their profession are more stringent than those typically encountered by NIBs. In this sense, the 'interpreter advantage hypothesis' posits that the development of expert interpreting skills may further enhance specific linguistic and executive functions in bilinguals.

The interpreter advantage hypothesis is also motivated by research showing that the acquisition of field-specific expertise enhances relevant cognitive skills in several populations. These include professional chess-players (de Groot 1946/1978), skilled videogame players (Green and Bavelier 2003), writers, dancers, truck-drivers (Ericsson 2006), waiters (Bekinschtein et al. 2008), and frequent Internet communicators (Johnson 2008). This paper seeks to assess whether interpreting expertise may also bring about such types of cognitive enhancement. To this end, a selection of studies will be reviewed in order to establish preliminary data patterns. The underlying prediction is that PIs should outperform NIBs in specific linguistic and executive function tasks.

2. PIs vs. NIBs (and other populations): A review of the evidence

This section reviews empirical studies comparing PIs with NIBs in various psycholinguistic and cognitive psychology tasks. Some of the tasks also involved interpreting students (ISs) and/or MLs. Excluded from the review are those studies that perform intra- and inter-group comparisons between ISs and NIBs without including PIs in their samples (e.g., Chincotta and Underwood 1998; Christoffels et al. 2003; Darò 1989; Darò and Fabbro 1994; Tzou et al. 2011), as well as studies that compare PIs with MLs (Padilla et al. 2005) or ISs (Fabbro et al. 1991) without including NIBs, and studies focusing solely on PIs (e.g., Proverbio and Adorni 2010; Shlesinger 2003). Such studies will be addressed in relevant discussion sections but will not be the focus of the review presented here.

The studies employ several experimental paradigms, which are organized in two categories: namely, linguistic and executive function tasks. When a given study includes multiple tasks from both categories, or when the results of the same task are analyzed in terms of both linguistic and executive variables, these are considered separately in their respective categories. An integrative discussion of the evidence is provided for each of these domains. The Appendix offers a summary of all studies and additional participant data — e.g., PI groups' mean ages and years of professional experience.

2.1 Evidence from linguistic tasks

The evidence on how interpreting expertise influences linguistic processing comes from three broad areas: error detection, discourse processing, and lexico-semantic processing. Yudes et al. (2012) conducted an error detection study with PIs, NIBs, ISs, and MLs. Participants were instructed to read English texts and mark whatever aspects they perceived to be incorrect. While participants did not exhibit considerably different behavior in lexical error detection, PIs did outperform all other groups in semantic error detection, and also outperformed MLs in syntactic error detection. A verification questionnaire also revealed an advantage for PIs in answering open-ended questions.[3] Further statistical analyses showed that these results were not due to either L2 or WM differences among the groups. These findings partially corroborated those of Fabro et al. (1991), who showed that PIs outperform ISs in detecting semantic errors, but not syntactic errors. Crucially, it indicates that PSIs develop superior abilities to formulate conceptual units after text processing.

Dillinger (1994) compared the performance of PIs and NIBs during a simultaneous interpreting session followed by an SL text recall task. Interpreting accuracy was significantly higher in PIs than in NIBs. Target text analyses revealed no between-group differences in syntactic processing or SL text analysis. However, PIs were more efficient at constructing propositional information units during the task. This experiment, too, suggests that interpreting experience correlates with enhanced semantic processing but involves no differences in syntactic processing.

Bajo et al. (2000) investigated lexico-semantic processing skills in PIs, ISs, NIBs, and MLs. The authors found that PIs outperformed NIBs in sentence reading, lexical decision on non-words, and categorization of non-typical exemplars. Christoffels et al. (2006) compared PIs with two groups of NIBs: bilingual university students and highly proficient L2 teachers. Relative to the students, PIs were significantly faster on word translation and only *marginally* faster on picture naming, and both groups processed cognates faster than non-cognates. However, no such differences were found between PIs and teachers.

3. The questionnaire in this study was an additional measure the authors included to assess comprehension of the texts analyzed.

Ibáñez et al. (2010) assessed language access and switching in translators and NIBs.[4] The subjects performed a self-paced reading task, including critical cognate and non-cognate words. Once the text had been read in its entirety, each sentence had to be repeated out loud. In a second experiment, two new groups performed the same task, except that they were not instructed to repeat each sentence. The only differences between the groups emerged in Experiment 1 (by eliminating sentence repetition, the task no longer taxed WM resources; thus, the ensuing results could be presumed to reflect strictly linguistic effects). Here, the translators were slower at reading the critical words, and they were the only group showing a cognate effect — they processed cognates faster than non-cognates.

Finally, in an evoked response potentials (ERPs) study, Elmer et al. (2010) explored how interpreting expertise may bring about distinctive neuronal adaptations. To this end, NIBs and PIs (specialized in L2-L1 translation only) performed a semantic decision task. The participants were asked to decide whether each noun pair presented was congruent or incongruent. The stimuli were presented in all possible language combinations. Behavioral results were similar for both groups. However, ERP data revealed enlarged N400 responses for PIs in all conditions but one, namely, the one corresponding to the direction professionally practiced (L2-L1).[5] Additional statistical analyses showed that these differences between PIs and NIBs reflect the impact of interpreting *training*, regardless of the years of *professional* interpreting practice.

2.1.1 *Discussion*

At present, the evidence about the linguistic impact of interpreting expertise is scant. Moreover, available studies employ varied paradigms, tapping different aspects of language processing. While no definitive conclusions can be drawn from a limited number of studies, some trends emerging from these studies can be pointed out.

4. Throughout Ibáñez et al.'s (2010) paper, translation experts are referred to as 'translators' as opposed to 'interpreters.' While it is not clear which translation mode they were experts in (e.g., written translation or simultaneous interpretation), the variables assessed in the study (i.e., cognate status and language switching) can be reasonably presumed to have a similar impact on any expert in interlingual reformulation (see Ibáñez et al. 2010: 257).

5. The N400 component is a negative neurophysiological deflection peaking at about 400 ms post-stimulus onset. It is modulated by semantic incongruences and, more generally, by stimuli that diverge from previous semantic expectations.

2.1.1.1 *Semantic processing effects*

The greatest advantages of PIs have been found in skills involving semantic processing, including semantic error recognition (Fabbro et al. 1991; Yudes et al. 2012) and access to lowly entrenched conceptual representations (Bajo et al. 2000). This pattern is consistent with the neurophysiological finding that PIs feature "a training-induced altered sensitivity to semantic processing within and across L1 and L2" (Elmer et al. 2010: 152). The superior interpreting accuracy of PIs reported by Dillinger (1994) may also reflect enhanced efficiency in semantic processing. Bajo et al. (2000) showed that text comprehension in PIs is not undermined by their comparatively faster reading speed. Taken together, these findings suggest that interpreting expertise may enhance semantic (conceptual) processing.

2.1.1.2 *Grammatical and word-form processing effects*

The situation is different when grammatical or word-form levels of representation are involved in the tasks. Interpreting expertise does not seem to enhance syntactic error recognition (Yudes et al. 2012; Fabbro et al. 1991) or syntactic processing at the discourse level (Dillinger 1994). Neither do PIs seem to be particularly advantaged in picture naming, a task involving both the semantic and the word-form levels of processing (Christoffels et al. 2006). The same seems to be true of strictly lexical tasks, such as word reading (Ibáñez et al. 2010, Exp 1) and lexical decision on actual words (Bajo et al. 2000). All these findings support the view that word-form processing is not influenced by interpreting expertise.

An apparent caveat to the above claim comes from the domain of word translation, as PIs translated words faster, more accurately, and less asymmetrically than non-interpreter bilingual students (Christoffels et al. 2006). However, in that same study, no such differences were observed between PIs and L2 teachers, who had higher L2 proficiency ratings than the students. Thus, this pattern of results actually reinforces the view that interpreting expertise *per se* does not enhance word-form processing. In this sense, Christoffels et al. (2006: 339) conclude that "[l]exical retrieval is not 'boosted' any further by professional interpreting than by another profession that demands high proficiency in the L2 (i.e., the teaching of English)."

Finally, cognates are of interest since they evince language-access modes in bilinguals. Specifically, cognate effects are assumed to reflect non-selective access since they imply parallel activation of both the target and the non-target language. Conversely, the absence of a cognate effect suggests language-selective access (van Hell and Dijkstra 2002). In their study with NIBs and *translators*, Ibáñez et al. (2010) found that only the latter presented cognate effects independent of task demands. The authors suggest that only expert translators are able to cope with higher task demands without changing their language-access mode. While this conjecture cannot be *a priori* assumed to apply to PIs, it does open a space for new research on the topic. Also, such a possibility suggests that the presence of similar cognate effects in both PIs and NIBs in the two word-translation experiments conducted by Christoffels et al. (2006) may be due to low task demands.

2.1.2 *Linguistic effects: Summary*

In sum, evidence from linguistic tasks suggests that translation expertise might enhance semantic functions but not syntactic or word-form processing, and that it may render non-selective language access more constant and less susceptible to task demands. However, these statements can be taken only as tentative claims given the limitations and methodological variability of the studies.

2.2 Evidence from executive function tasks

A different set of data sheds light on how interpreting expertise affects executive processing, including WM storage, WM storage-and-processing, and cognitive control.

The study by Bajo et al. (2000) also included WM tasks with visual stimuli. PIs had longer digit and reading spans than both ISs and NIBs, which did not differ from each other. A follow-up experiment consisted in a free-recall task under two conditions, with and without articulatory suppression. Between-group differences were found only in the former, as PIs remembered significantly more words.

Similarly, in Christoffels et al.'s (2006) study, PIs outperformed bilingual students and L2 teachers on reading span, speaking span, and word span tasks — all with visual stimuli. An interpreting advantage on reading span was also found in other studies (Signorelli et al. 2011, previously documented in Signorelli 2008; Yudes et al. 2011). Additionally, Signorelli et al. (2011) reported an interpreter advantage on non-word repetition but no specific enhancements in articulation rate or cued recall.

In a series of experiments using auditory stimuli, Köpke and Nespoulous (2006) obtained an intriguing pattern of results. Here, it was ISs who performed significantly better than PIs, NIBs, and MLs on listening span, free recall without articulatory suppression, and semantic cued recall. No between-group differences were found on free-recall with articulatory suppression, phonological cued recall, or a Stroop task.

Other studies have explored cognitive control processes. Yudes et al. (2011) found that PIs had greater cognitive flexibility than NIBs and MLs, and that this advantage was not due to their superior WM spans. In contrast, the ability to inhibit non-verbal information was not particularly influenced by interpreting expertise. Further support can be found in the study conducted by Ibáñez et al.

(2010). Their self-paced reading tasks involved both switching and non-switching trials. When sentences had to be repeated upon completion, interpreters showed no differences between the two types of trials, either in L1 or in L2. NIBs, on the other hand, performed the switching trials more slowly when the sentences were in L1. When participants were not required to repeat each sentence upon completion, both groups performed similarly.

2.2.1 *Discussion*

While not entirely consistent, the evidence indicates that interpreting expertise improves *some aspects* of executive function. Contradictory findings do not come as a surprise; while executive functions are task-dependent, the studies reviewed present great methodological variability. Still, their joint analysis suggests certain common trends.

2.2.1.1 *WM effects*

According to Baddeley (1986, 2000), WM comprises four components. The central executive acts coordinates activity in the other subordinate components. The phonological loop stores and rehearses auditory verbal information.[6] The visuo-spatial sketchpad subserves similar functions but handles visual input. Whereas simple WM tasks (e.g., digit span, word span) mainly measure this system's storage capacity, complex tasks (e.g., reading span, listening span) measure the ability to coordinate storage and processing (Engle et al. 1999).

First, the simple span tasks using *visual* stimuli (Bajo et al. 2000; Christoffels et al. 2006; Yudes et al. 2011) indicate that interpreting expertise hones the storage capacity of the phonological loop. Conversely, no group differences were shown in Köpke and Nespoulous's (2006) *auditory* span tasks. It is then possible that the impact of interpreting expertise on simple phonological storage depends, among other factors, on input modality. If the last statement is true, the proposed input modality effect might be modulated by the nature of the stimuli. Indeed, *auditory non-word* recall was better in PIs than in NIBs (Signorelli et al. 2011). Hence, there may an interpreter WM advantage for auditory input, perhaps restricted to information that is not represented in long-term memory — i.e., non-words, as opposed to real words. One reason for this advantage may be that PIs are used to

6. The phonological loop includes a phonological store (which maintains information active for as long as 2 seconds) and a subvocal rehearsal process (which allows for phonological traces to be reactivated through silent repetition of articulatory gestures). Also, this model includes an episodic buffer, which serves as an interface between the latter two components and long-term memory.

learning and repeating novel proper names — which resemble non-words — at the meetings for which they interpret (Signorelli 2008).

Similarly, PIs' advantages on information recall seem to occur only under specific conditions, namely, when subvocal rehearsal is impeded (Bajo et al. 2000; Köpke and Nespoulous 2006). Bajo et al. (2000) observed that articulatory suppression during free recall was detrimental for ISs but not for PIs. Intriguingly, however, Köpke and Nespoulous (2006) found that ISs outperformed PIs under such a condition. Although further research is needed, such discrepancies might be partially related to input modality differences. Be that as it may, the fact that bilinguals with interpreting training (PIs and ISs) consistently outperformed NIBs in tasks impeding subvocal rehearsal suggests that field-specific training may boost the allocation of attentional resources. The WM advantages of PIs relative to NIBs seem be attenuated or even disappear when recall is aided by cues (Köpke and Nespoulous 2006; Signorelli et al. 2011, previously documented in Signorelli 2008). For Signorelli (2008), this pattern suggests that PIs' WM advantages may be subject to a ceiling effect, on the assumption that cued recall is more demanding than non-word repetition — where PIs did outperform NIBs. On the contrary, it is likely that cues *reduce* rather than increase retrieval effort, rendering intergroup differences nonexistent or negligible. In fact, the use of cues facilitates recall throughout adulthood (Bregman 1968; Perry and Wingfield 1994) and in amnesic patients (Isaac and Mayes 1999a, 1999b).

Interpreting expertise also seems to boost concurrent memory processing and storage. When item encoding alternates with brief sentence-reading episodes, PIs perform significantly better than other bilingual groups (Bajo et al. 2000; Christoffels et al. 2006; Signorelli et al. 2011; Yudes et al. 2011). Corroborating evidence is provided by a study that compared freshman ISs with NIBs (Tzou et al. 2011), which suggests that this advantage may appear shortly after the onset of formal training (see Section 4.3). This advantage in complex tasks, however, might also be sensitive to presentation modality — complex storage-and-processing with auditory stimuli was better for ISs than PIs in Köpke and Nespoulous's (2006) study. An additional factor underlying these differences may be L2 proficiency (see Tzou et al. 2011).

2.2.1.2 *Inhibitory control effects*

The results obtained by Yudes et al. (2011) suggest that inhibitory control on nonverbal information is not affected by interpreting experience. It is noteworthy that the PIs' performance in this domain was not superior even to that of MLs, as previous studies reported a bilingual advantage (Bialystok 2006). Yudes et al. (2011) reason that their results may be related to the use of late unbalanced bilinguals, adding that "the cognitive advantages related to bilingualism might only be evident for balanced bilinguals" (Yudes et al. 2011: 7). However, this conclusion is inconsistent with the advantages observed for unbalanced bilinguals (PIs, ISs, and NIBs) over MLs in other studies (see Appendix). Other possible reasons for this lack of significant differences may involve the participants' age, language proficiency, or even general intelligence (Roca et al. 2010).

Conversely, some of the results presented by Ibánez et al. (2010) indicate that translation expertise does alter inhibitory processes in the *verbal* domain. Insofar as switching costs reflect inhibitory processes, such findings indicate a language control advantage through elimination of switching costs in high-demand tasks. The authors speculate that translators may develop an alternative control mechanism based on identification of language-specific cues to signal the appropriate language, followed by increased focus on the words of the intended language. What remains unclear is whether these findings may be generalized to PIs. However, the finding that interpreting expertise enhances cognitive flexibility (Yudes et al. 2011) suggests an advantage at reframing and updating mental schemas, a skill that would seem essential for the alternative mechanism proposed by Ibáñez et al. (2010).

2.2.2 *Executive function effects: Summary*

The evidence from research on executive tasks suggests two sets of postulates. On the one hand, PIs do not seem to possess superior WM skills for storing known information that is presented auditorily or prompted by phonological cues. Neither is there any clear indication that they may develop superior inhibitory control abilities. On the other hand, PIs seem to be more effective at storing known information triggered by visual input and novel information triggered by auditory input, especially when subvocal rehearsal is impeded. More generally, interpreting expertise seems to enhance WM capacity for handling concurrent storage and processing.

3. Limitations

Two important limitations currently facing the interpreter advantage hypothesis are the paucity of relevant evidence and the methodological variability of the available studies. Moreover, most of those studies fail to provide reliable measures of the PIs' expertise. The key variable used in these studies to measure expertise is years of professional experience. However, such information, on its own, provides no useful data as to how much actual practice the participants have accumulated in their careers, or what the quality of their work is. Also, whereas the PIs in some studies had a mean of 15.7 years of professional experience (Christoffels et al. 2006), those in others had fewer than 5 (Bajo et al. 2000). Large variation in experience makes this measure unreliable on its own, and therefore other measures need to be used to gauge interpreting expertise.

As shown in the Appendix, three studies considered hours of professional practice as an additional variable. While this does constitute a useful measure, other types of information, such as work settings, type of training received, and interpreting quality seem to be necessary to gain clearer insights. The same considerations apply to the measures used to form groups of ISs: their years of training reveal nothing about the type and intensity of training, or the level of expertise reached.

Limitations in the control of important subject variables also make it difficult to reasonably rule out alternative interpretations of the observed effects. One possibility is that bilinguals with stronger language and executive function skills may be better predisposed to enter the profession. Given these shortcomings, what the preceding review sets forth are preliminary data patterns rather than firm conclusions. Before they can be accepted as reliable knowledge, such patterns require further testing through studies closely replicating one another and controlling for critical subject variables.

4. Other empirically motivated questions

In addition to the above data patterns, the evidence gives rise to other related questions, which might pave the way for future research.

4.1 Are linguistic and executive advantages dependent on one another?

Linguistic and executive abilities are in constant interplay during simultaneous interpreting. The present review suggests that aspects of both domains are enhanced in PIs. But do their linguistic advantages depend on their executive advantages, or vice versa?

WM and other executive functions may have an impact on linguistic processing, both for native (Daneman and Merikle 1996; Hartsuiker and Barkhuysen 2006) and non-native (Michael and Gollan 2005) languages. Gile (1995) has argued that WM is important for comprehension processes during interpreting, and there is evidence that higher memory capacity correlates with better word translation skills in NIBs (Kroll et al. 2002). However, in the development of interpreting expertise, the enhancement of linguistic subskills appears to be orthogonal to that of executive abilities. Yudes et al. (2012) demonstrated that the PIs' advantages on semantic error detection and global comprehension were not due to WM superiority. At the same time, a WM advantage in PIs does not necessarily correlate with superior lexical retrieval (Christoffels et al. 2006, Exp 2). In this sense, a previous study conducted only with NIBs demonstrated that WM and word translation skills are independent subskills, contributing separately to interpreting performance (Christoffels et al. 2003). Also, through experiments comparing PIs with MLs, Padilla et al. (2005) conclude that the PIs' distinctive ability to engage in concurrent SL comprehension and TL production depends on word knowledge rather than on increased WM storage capacity or superior skills at coordinating concurrent processes. In sum, linguistic and executive abilities appear to constitute separate components of interpreting competence, and their enhancement — or lack thereof — appears to be independent from that of the other domain.

4.2 Relative to MLs, are all of the PIs' advantages due to a cumulative effect of bilingualism and interpreting expertise?

The interpreter advantage hypothesis assumes that, relative to MLs, PIs are doubly advantaged, as their cognitive skills would be enhanced by the cumulative influence of bilingualism and interpreting expertise. Direct evidence to test this notion can be obtained in the studies comparing the performance of PIs to that of NIBs and MLs on linguistic or executive tasks. Four such studies have been presently reviewed. If the double advantage assumption is correct, then performance scores should be consistent with this formula: PIs (and/or ISs) > NIBs > MLs.[7]

An analysis of *mean scores* indicates that the formula correctly describes group rankings in 8 out of the 10 relevant tasks — namely, syntactic error detection, semantic error detection, global comprehension (Yudes et al. 2012), reading speed (Bajo et al. 2000), listening span, free recall with articulatory suppression, category-cued recall (Köpke and Nespoulous 2006), and cognitive flexibility (Yudes et al. 2011). However, such differences did not always reach statistical significance. Hence, while not implausible, the notion that bilingualism and interpreting experience bring about cumulative enhancements remains a matter of speculation.

In contrast, two task conditions revealed a significant PI advantage but in which the formula did not apply — namely, lexical decision on non-words and categorization of non-typical exemplars (Bajo et al. 2000). Here, MLs actually obtained considerably higher scores than NIBs. This suggests that some cognitive skills may be enhanced specifically by interpreting experience, as opposed to bilingualism. Such a possibility could be tested through experiments aimed at

7. The '>' symbol in this formula should be read as 'better than,' as opposed to 'higher than,' given that performance superiority is indicated by higher scores in some tasks (e.g., error detection, memory span) and by lower scores in some others (e.g., lexical decision as measured by RTs).

disentangling both variables via comparisons of PIs, NIBs, and MLs on linguistic and executive tasks.

4.3 When does the interpreter advantage begin to develop?

The PIs in the studies reviewed had at least one year of professional experience — in fact, many of the participants had ten or even twenty years of experience. Assuming that they had received training for a minimum of two years before entering the profession, participants possessed anywhere from three to twenty-four years of interpreting practice. However, some of their advantages may have appeared during the early stages of training. The studies including ISs and NIBs in their samples provide critical evidence in this respect.

Bajo et al. (2000) showed that the scores of freshman ISs and MLs on several language tasks were improved only in the former group upon retesting a few months later. For her own part, in an auditory shadowing experiment, Darò (1989) found that NIBs made significantly more errors than freshman ISs.[8,9] More recently, Tzou et al. (2011) showed that one year of interpreting training is enough to produce significant enhancements in WM relative to NIBs — although this possibility is weakened by the absence of WM differences between ISs and NIBs in a previous study (Chincotta and Underwood 1998). Finally, and somewhat intriguingly, in Köpke and Nespoulous's (2006) study ISs had the best scores on all the tasks yielding significant group effects — even outperforming PIs. Taken together, these findings suggest that aspects of the interpreter advantage may develop shortly after the onset of formal training, rather than after several years of experience in the profession. A similar conclusion was reached by Elmer et al. (2010) in their ERP study. This issue could be adequately examined using longitudinal studies in which aspiring interpreters are tested before starting training and then several times before completing their interpreting programs.

4.4 Further issues for future research

There are other relevant issues to explore in future research. First, more studies are needed to determine whether the advantages of SPIs relative to NIBs occur similarly in L1 and L2 tasks. For example, in Christoffels et al.'s (2006) study,

8. Participants were sent lists of individual words to one ear. L1 words had to be immediately repeated, while L2 words had to be immediately translated into L1. Simultaneously, participants were sent 1 to 3 target words to the opposite ear and instructed to memorize them in order to report them at the end of each list.

9. This group of NIBs was about to begin interpreting training.

SPIs performed speaking and reading span tasks similarly in both L1 and L2. Conversely, their performance was asymmetrical in other tasks, such as semantic error detection (Fabbro et al. 1991) and word span (Christoffels et al. 2006). No clear pattern emerges from these preliminary data, and the same is true for studies comparing ISs and NIBs (Chincotta and Underwood 1998; Tzou et al. 2011).

Second, PIs may develop specific strategies to cope with the cognitive demands of certain processes. Fabbro et al. (1991) suggest that interpreters may be trained to exert a more conscious control of meaning than of syntax, disregarding syntactic errors in the input. Ibáñez et al. (2010) also propose that translators and NIBs may confront monolingual tasks in different manners. However, the distinctive strategies that are developed through the acquisition of interpreting expertise remains unknown.

Finally, performance on specific WM and cognitive flexibility tasks may be related to fluid intelligence, which reflects the ability for general abstract thought and reasoning (Roca et al. 2010). However, no study has yet explored the role of this construct in the reported interpreter advantages. This potential line of research may contribute to explaining the variability observed in classical executive function tasks.

5. Conclusion

The interpreter advantage hypothesis proposes that PIs develop task-specific skills to cope with the stringent cognitive demands of their occupation and that such skills generalize to more efficient linguistic and executive abilities in non-interpreting tasks. Evidence to test the hypothesis has been obtained in a number of studies. However, due to design heterogeneity and methodological limitations, these results do not warrant any definitive conclusions. Still, their joint analysis reveals some preliminary data patterns. In particular, PIs seem to develop an advantage for semantic processing, aspects of WM storage capacity and processing functions, and cognitive flexibility between competing schemas. Available data also gives rise to questions that have not been hitherto addressed in empirical studies: Are linguistic and executive enhancements in PIs independent of each other? Are all the superior skills of PIs cumulatively enhanced by the double influence of bilingualism and interpreting experience? And how soon after the onset of formal training do these advantages appear? In sum, the preliminary data patterns presented suggest questions about the relationship between interpreting expertise and linguistic processing, and outline several lines of investigation for an untapped, yet incipient, field of research.

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Appendix

Summary of the studies comparing PIs with NIBs on linguistic and executive tasks.

Study	Subjects (*N* bet. parentheses)	Languages	PIs' expertise data means	Tasks, conditions, or aspects studied	PI adv.	Observations
Bajo et al. (2000)	PIs (10) NIBs (10) ISs (10) MLs (10) All bilinguals: unbalanced, high L2 proficiency.	NL: Spa L2: Eng	Exp: 1–5 years Age : 23–33	Sent reading Lex dec Sem cat D span R Span FR with AS FR without AS	Yes Yes Yes Yes Yes Yes No	Lex dec adv: Only on non-words. Sem cat adv: Only on non-typical exemplars
Christoffels et al. (2006)	PIs (13) NIBs (sts) (39) NIBs (tchs) (15) All subjects: unbalanced bilinguals, high L2 proficiency.	NL: Dut L2: Eng	Exp: 15.7 years Age: 48.5	Pict nam Word trans R span S span W span	No No Yes Yes Yes	Only a marginal adv. for PIs relative to sts in Pict nam.

Summary (*continued*)

Study	**Subjects (*N* bet. parentheses)**	**Languages**	**PIs' expertise data means**	**Tasks, conditions, or aspects studied**	**PI adv.**	**Observations**
Dillinger (1994)	PIs (8) NIBs (8) All subjects: balanced bilinguals, high L2 proficiency.	NL: Eng L2: Fr	Exp: 8.5 years (3830 hours) Age: 45	Prop acc in SI Synt proc in SI	Yes No	
Elmer et al. (2010)	PIs (11) NIBs (11) All subjects: unbalanced bilinguals, high L2 proficiency.	NL: Ger L2: Eng	Exp: 10.9 years (7.7 hs weekly) Age: 37.8	Sem dec	No	Reduced N400 amplitudes in PIs in trained direction (L2-L1).
Ibáñez et al. (2010)	Trans (12) NIBs (12) All subjects: unbalanced bilinguals, high L2 proficiency. Professional modality of Trans is not specified.	NL: Spa L2: Eng	Exp: 2+ years (translation)	Cog proc SPR NCog proc SPR	No No	L1 reading: NIBs better than Trans. Increased switching costs in L1 for NIBs only.
Köpke, and Nespoulous (2006)	PIs (21) NIBs (20) ISs (18) MLs (20) All bilinguals: unbalanced, high L2 proficiency.	NL: Fr L2: Eng	Exp: 16.9 years Age: 44.4	M span L span FR without AS Cued recall Stroop task	No No No No No	ISs outperformed all other groups on L span, FR without AS, and category-cued recall.
Signorelli et al. (2011)	old PIs (13) young PIs (12) old NIBs (11) young NIBs (11) All subjects: unbalanced bilinguals, high L2 proficiency. All subjects tested only in L2.	L2: Eng	Old PIs Exp: 21.5 years Age: 56.2 Young PIs Exp: 4.72 years Age: 34.5	Art rate Non-word rep Cued recall R span	No Yes No Yes	
Yudes et al. (2011)	PIs (16) NIBs (16) MLs (16) All bilinguals: unbalanced, high L2 proficiency.	NL: Spa L2: Eng	Exp: 10.8 years Age: 36.3	R span WCST Simon Task	Yes Yes No	Advs independent of WM span.

Summary (*continued*)

Study	**Subjects (*N* bet. parentheses)**	**Languages**	**PIs' expertise data means**	**Tasks, conditions, or aspects studied**	**PI adv.**	**Observations**
Yudes et al. (2012)	PIs (19) NIBs (19) ISs (19) MLs (19) All bilinguals: unbalanced, high L2 proficiency.	NL: Spa L2: Eng	Exp: 9.5 years (15 hs monthly) Age: 36.8	R span Lex ER Synt ER Sem ER Glob Comp	Yes No No Yes Yes	Glob Comp adv: only on open-ended questions. Advs independent of WM span.

Subjects
ISs: interpreting students; MLs: monolinguals; NIBs: non-interpreter bilinguals; PIs: professional interpreters; sts: university students; tchs: L2 teachers; Trans: translators.

Languages
NL: native language; L2: second language; Eng: English; Dut: Dutch; Fr: French; Ger: German; Spa: Spanish.

Tasks, conditions, or aspects studied
Art rate: articulation rate; Cog proc SPR: cognate processing in self-paced reading; D span: digit span; FR with AS: free recall with articulatory suppression; FR without AS: free recall without articulatory suppression; Glob Comp: global comprehension; Lex ER: lexical error detection; Lex dec: lexical decision: L span: listening span; M span: memory span (including digit and word span); NCog proc SPR: non-cognate processing in self-paced reading; Non-word rep: non-word repetition; Pict nam: picture naming; Prop acc in SI: propositional accuracy in simultaneous interpreting; R span: reading span; Sem cat: semantic categorization; Sem ER: semantic error detection; Sem dec: semantic decision; Sent reading: sentence reading; S span: speaking span; Synt ER: syntactic error detection; Synt proc in SI: syntactic processing in simultaneous interpreting; W span: word span; WCST: Wisconsin Card Sorting Test; Word trans: word translation.

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