Acta Psychologica 155 (2015) 82–91

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/ locate/actpsy

Simultaneous interpretation selectively influences working memory and attentional networks

Julia Morales [a,*], Francisca Padilla [a], Carlos J. Gómez-Ariza [b], M. Teresa Bajo [a]

[a] Brain, Mind and Behavior Research Center, University of Granada, C/Profesor Clavera s/n, 18071 Granada, Spain
[b] Department of Psychology, University of Jaén, Campus las Lagunillas, 23071 Jaén, Spain

ARTICLE INFO

Article history:
Received 20 April 2014
Received in revised form 7 November 2014
Accepted 18 December 2014
Available online 8 January 2015

PsycINFO codes:
2300 Human Experimental Psychology
2340 Cognitive Processes
2343 Learning & Memory

Keywords:
Simultaneous interpreting
Expertise
Updating
Alertness
Orienting

ABSTRACT

Recent research has shown that becoming an expert in a certain domain may lead to a transfer of the acquired skills to other domains requiring similar abilities. Thus, the cognitive skills acquired by professional interpreters after intensive training may also transfer to other domains. Simultaneous interpreters are known to develop high working memory capacity (e.g., Christoffels, de Groot, & Kroll, 2006; Signorelli, Haarmann, & Obler, 2012). However, little is known about transfer of other processes such us updating and some aspects of attention also involved in interpretation. In Experiment 1, we found that interpreters outperformed a control group in updating skills, as measured through a dual version of the *n*-back task (Jaeggi et al., 2007). In Experiment 2, use of the ANTI-V allowed us to reveal that interpreting differentially modulates the interactions between attentional networks. Thus, we found no group differences in conflict resolution, but the interaction between the alertness and orienting networks differed between interpreters and non-interpreters. Taken together, these results suggest that experience in simultaneous interpreting transfers to other domains, but this transfer seems specific to the cognitive processes more closely involved in the interpreting tasks.

1. Introduction

Recent research has shown that becoming an expert in a certain domain may lead to a transfer of the acquired skills to other domains that require similar abilities. For instance, skilled video-game players develop better attentional processing (Green and Bavelier, 2007), musical training influences executive functioning and fluid intelligence (e.g., Bialystok and Depape, 2009; Habib and Besson, 2009; Schellenberg, 2004), and specific training in certain cognitive functions, such as working memory, has shown to modify attentional processes (e.g., Lilienthal et al., 2013). Of relevance here, bilingual speakers have also been shown to develop an efficient cognitive control across non-verbal domains (for a review, see Kroll and Bialystok, 2013).

Simultaneous interpretation is undoubtedly an extremely demanding cognitive activity and, as a consequence, it should influence a number of cognitive functions. Interpreting requires processing (listening to) a given source language while producing (speaking) in a different target language. In addition, interpreters need to concurrently reformulate (translate) the incoming information into the target language. The biggest challenge for this complex task is simultaneity since many processes have to be performed concurrently, which requires an outstanding cognitive control system. To achieve successful interpretation, professionals need to coordinate two languages, maintaining both as active and functional and without producing interference from each other (Christoffels and De Groot, 2004; Danks et al., 1997; Gile, 1991, 1997). In addition, they also need to retain and manipulate considerable amounts of information. Therefore, expert interpreters should rely on high level skills for controlling their attentional resources and managing information, which should be reflected in superior performance on tasks that involve resources similar to those recruited by simultaneous interpretation.

Findings from a variety of studies support the hypothesis that working memory (WM) contributes to successful interpreting and that interpreters outperform non-interpreters in WM capacity (Christoffels et al., 2003; Darò and Fabbro, 1994; Liu et al., 2004; Padilla et al., 1995; Tzou et al., 2012). However, some studies have failed to identify differences in WM between interpreters and controls (e.g., Köpke and Nespoulous, 2006; Liu et al., 2004; Nordet and Voegtlin, 1998). Because WM involves multiple processes, different WM paradigms may call upon these processes to varying extents, which in turn might produce variability across experiments (Köpke and Signorelli, 2012).

WM refers to the processes involved in temporarily storing and manipulating information in mind (e.g., Baddeley, 1986, 2003). Given that interpreting requires the temporary retention and processing of high quantities of verbal information in the source and target languages,

* Corresponding author. Tel.: +34 958 240667; fax: +34 958 246239.
E-mail addresses: mjulia@ugr.es (J. Morales), fpadilla@ugr.es (F. Padilla), cjgomez@ujaen.es (C.J. Gómez-Ariza), mbajo@ugr.es (M[a]. T. Bajo).

http://dx.doi.org/10.1016/j.actpsy.2014.12.004
0001-6918/

many studies have focused on studying the WM skills in interpreters. Most models agree that WM involves storage components and a control system in charge of coordinating the stored information (Baddeley and Hitch, 1974; Kane et al., 2001; Posner and DiGirolamo, 2000). Whereas the storage systems seem to be domain-specific for verbal and visuospatial information (Baddeley, 1986; Baddeley and Hitch, 1974), the executive component is thought to be domain-free in the ability to control processing (Engle, 2002). For example, Baddeley's influential model (Baddeley, 1986, 1996, 2000) proposes that WM is composed of two temporary memory stores (the phonological loop and the visual sketchpad), an episodic buffer for rehearsing the stored information, and a central executive that coordinates the active contents and is responsible for high-level cognitive activities such as planning, coordinating and updating the flow of information, as well as retrieving contents from long-term memory (Baddeley, 1996). These central executive processes are in charge of monitoring task-relevant information and are closely related to the updating function proposed by Miyake (Miyake et al., 2000) as one of the main components – along with inhibition and set shifting – of his influential model of executive control. From this perspective, WM involves the maintenance and monitoring (updating) of task-relevant information.

Similarly, interpreting goes beyond the simple maintenance of verbal information since it entails continuous monitoring and updating of the input and output of verbal information. The incoming information needs to be actively understood and manipulated (translated); furthermore, information must be updated so that new information should substitute the one that is no longer relevant. The cognitive requirements of professional interpreters may differ from other bilinguals since interpreters need to not only manage the two languages, but also keep them active in mind so as to manipulate them. Therefore, one might expect that professional interpreters excel on tasks that tap into the executive component of WM. However, a critical question remains whether the reported interpreters' benefits in WM reflect a general advantage in terms of executive control or if this advantage is related to memory (maintenance) processes. To answer this, it might help to clarify the source of the inconsistencies found in previous studies and to better understand the mechanisms underlying efficient interpreting.

To measure WM capacity, most of the research has employed complex-span tasks, which involve both memory and executive processes. Complex-span tasks typically require participants to maintain short lists of information in memory while simultaneously processing other information, such as solving equations (e.g., Turner and Engle, 1989) or reading sentences (e.g., Daneman and Carpenter, 1980). Thus, while the central task requires storage of a number of items (short-term memory), the secondary task requires the continuous monitoring and updating of the information in mind. To successfully perform the memory task, the participant needs to either maintain or discharge the information depending on its relevance (i.e., the to-be-recalled word and the digits of the equation to be solved). Consequently, although the critical score in complex-span tasks is the number of items correctly recalled (the so-called memory span), variance in WM span reflects memory skills as well as the ability to manipulate information while avoiding interference caused by the concurrent tasks (e.g., Engle, 2002; Kane et al., 2001, 2007). Given that WM capacity is a limited resource involved in many of the mental operations performed while interpreting, high WM capacity could be crucial for efficient interpreting (De Groot and Christoffels, 2006).

Whereas some previous studies have found superior WM capacity in interpreters, relative to non-interpreters, on a variety of span tasks (Christoffels et al., 2006; Padilla et al., 1995; Signorelli et al., 2011; Tzou et al., 2012), others have failed to observe such an advantage (see Köpke and Signorelli, 2012, for a review). Most importantly, these mixed results could be due to the fact that different studies use different span tasks which may involve the storage and updating of information to varying extents. Thus, differences in maintenance and/or attentional-executive skills might be responsible for the conflicting results. To evaluate the relative involvement of storage and executive WM components, some researchers have distinguished between simple (storage) and complex span measures (storage plus processing), with contradictory results. For example, Köpke and Nespoulous (2006) found that while interpreters failed to show an advantage on simple-span tasks (requiring only temporal maintenance of information), they outperformed non-interpreters on complex-span tasks, thus suggesting that interpreters' advantages in WM tasks are due to differences in executive control. In contrast, others have found the opposite pattern of results, with equivalent performance of interpreters and non-interpreters on complex WM tasks (listening span task; Liu et al., 2004; Stavrakaki et al., 2012), but better performance by interpreters on storage tasks (e.g., digit, word, and non-word span tasks). This finding would suggest that interpreters excel in the ability to maintain information in mind. Therefore, it is unclear from span tasks whether the reported advantages of interpreters in WM capacity reflect higher functioning in storing information, a better ability to manipulate information or a combination of both.

An interesting source of evidence to disentangle the relative involvement of each WM component comes from studies that measure free recall under conditions of articulatory suppression. In this paradigm, the verbal storage is overloaded by asking participants to produce irrelevant speech (e.g., the word “the”) while memorizing groups of words. The concurrent articulation prevents participants from subvocally rehearsing so that the encoding of phonological information is consequently disrupted (Baddeley, 1986; Baddeley and Larsen, 2007). Interestingly, this task is closely related to simultaneous interpreting as both activities involve comprehension and language production at the same time. In fact, it has been suggested that interpreting is an extreme form of articulatory suppression (Yudes et al., 2012) and that the two tasks may require similar processes to be solved efficiently.

A number of studies have found that as monolinguals and bilinguals (with no professional experience in interpreting) reduce their recall of words under articulatory suppression conditions, interpreters are unaffected by the production of irrelevant speech (Chincotta and Underwood, 1998; Padilla et al., 1995, 2005; Yudes et al., 2012). Interestingly, they found that the interpreters' advantage in coordinating comprehension and production seems to rely more on linguistic skills than on WM storage capacity and coordination of cognitive resources. For example, in a series of experiments, Padilla et al. (2005) compared a group of interpreters, a group of matched high span monolinguals, and a control monolingual group with an average WM span. In Experiment 1 they found that whereas interpreters were unaffected by articulatory suppression, high WM participants showed a normal articulatory suppression effect that was similar to that seen in the control group. This result indicates that large WM capacity may be necessary but not sufficient to coordinate comprehension and production. In Experiment 2 the same participants were asked to study a list of words while performing a visuospatial secondary task. On this occasion all the participants were affected by the concurrent task, showing less recall in the dual-task condition. In addition, the cost of the articulatory suppression effect seems to be modulated by linguistic knowledge of the studied material (Padilla et al., 2005, Experiment 3) and the complexity of articulations (Yudes et al., 2012), thus suggesting that language skills may play a crucial role in the interpreters' superiority in coordinating comprehension and production.

Enhanced linguistic knowledge might also underlie high WM capacity since it has been shown that familiarity with a language influences WM storage capacity (Gathercole, 1995; Gathercole et al., 2001; Thorn and Gathercole, 2001). These findings, however, are compatible with the idea that efficient monitoring may also play a role in the interpreters' superior WM capacity and coordination of two languages in mind. Given that the former studies in this field essentially employed verbal material, their findings may be reflecting a combination of high language knowledge and enhanced executive-control capacity. However, if executive control is domain-free and