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Korenar, M.; Treffers-Daller, J.; Pliatsikas, C.

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Two languages in one mind: Insights into cognitive effects of bilingualism from usage-based approaches

Michal KORENAR | Amsterdam Center for Language and Communication, Department of Dutch Studies, University of Amsterdam, The Netherlands – Alzheimer Center Amsterdam, Department of Neurology, Vrije Universiteit Amsterdam, Amsterdam UMC location VUmc, The Netherlands

Jeanine TREFFERS-DALLER | Department of English Language and Applied Linguistics, University of Reading, UK

Christos PLIATSIKAS | School of Psychology and Clinical Language Sciences, University of Reading, UK – Centro de Investigación Nebrija en Cognición, Universidad Nebrija, Madrid, Spain

Bilingualism has been associated with changes in our language-related and domain-general cognition. However, it remains controversial whether bilingualism-related cognitive effects are robust and stable. Also, it is still unclear which aspects of bilingual experiences affect the plasticity of cognitive processes. This article offers a selective overview of the literature on bilingualism and cognition. We discuss results from studies which investigated the sources of cognitive plasticity in bilinguals, using prominent bilingual factors. We argue that, at least in part, the field deals with the controversies by viewing bilingualism through the perspective of usage-based (or experience-based) approaches, although such a link is not always made explicitly. Viewing bilingual variables as indicators of language use and engagement with both languages might offer promising ways forward while allowing for comparisons of existing studies on bilingualism with more recent ones, which build on the usage-based perspective more explicitly.

Key words: bilingualism, cognition, cognitive plasticity, executive function, usage-based

Klíčová slova: bilingvismus, exekutivní funkce, kognice, kognitivní plasticita, usage-based

1 Introduction

Speaking two or more languages appears to positively affect humans’ minds (Quinteros Baumgart – Billick, 2018), which has nurtured hopes that multilingualism could slow down neurocognitive decline (Voits et al., 2020). Although the potential beneficial effects of bilingualism have received great attention in the public debate, the academic discussion on this topic is still ongoing (Leivada et al., 2021). The spe-
cific effects of bilingualism on cognition are still poorly understood, which is reflected in variable results (Valian, 2015; van den Noort et al., 2019; Gunnerud et al., 2020). The apparent inconsistencies have sparked a controversy and have prompted a discussion on how the field should move forward (de Bruin et al., 2021; de Bruin – Della Sala, 2016; Paap et al., 2017), with some even pondering whether this line of research should be abandoned altogether (Paap et al., 2015).

This article aims to offer a thumbnail sketch of how the field of bilingualism is advancing towards an appreciation of the diversity of experiences held within the group of bilinguals to address existing controversies. We will focus on the following research approaches and prominent bilingual variables: comparisons of bilinguals with monolinguals, late bilinguals compared to early bilinguals, second language proficiency, age of language acquisition, language mixing practices, experiences of interpreters and translators, the context within which languages are learned, and the proportionality of language use. Given the richness and magnitude of research on cognitive plasticity in bilinguals, this article does not attempt to cover all possible approaches and variables studied so far. We aim to point towards a possible alternative way of looking at the existing results through the prism of usage-based approaches. Here we apply a reverse perspective to usage-based frameworks, which typically strive to capture the representation of language in our cognitive systems. Instead, we argue that the way two languages are used leaves traceable marks on our general cognitive processes. More specifically, we ponder whether viewing bilingualism as a set of experiences and usage-based patterns might offer unifying explanations to variable results reported in previous studies.

2 Usage-based perspective

One of the central ideas of the usage-based approach is that language is a product of our general cognition, and as such, it is constrained and shaped by our innate processing skills and general principles of cognitive learning (Backus, 2020). Therefore, these processes likely do not enable only learning related to language but subserve learning in general (Ellis et al., 2015; Beatty-Martínez – Dussias, 2018). Cognitive learning skills are sensitive to frequency effects in the information we encounter (Bybee, 2010). If we encounter a particular event frequently, our cognitive abilities are more likely to deal with that event effectively (Dell – Chang, 2014). For example, experienced drivers will likely be able to stop their car at a red light faster than beginners. Similarly, reading newspapers in German will become easier if we engage in this activity more often. In other words, our mind builds stronger associative bonds to events that emerge from experiences appraised as more probable.

Usage-based approaches have been primarily devised to offer a cognitively adequate language model that would build on the interconnection of three fundamental
language components: structure, meaning, and function (Backus, 2020). In the context of production and organization of language, the regularities and probabilities of specific language instantiations are mentally assessed by examining frequencies of constructions. The term construction is a technical term that refers to learned and conventionalized form-meaning (or form-function) pairings (Fried, 2013). The form of constructions denotes their syntactic, phonological, or prosodic properties. Meaning or function refer to semantic meaning, the context in which the form is used, the discursive and semantic-syntactic features of the construction, and the speaker’s intentions and the goals they want to achieve. Constructions are, therefore, units that are marked by associations between formal and functional features (Goldberg, 2013). These associations differ in their complexity and abstractedness and become solidified through increased exposure and language use. Their composition thus reflects speakers’ previous experiences (Bybee, 2010).

One of the theoretical advantages of usage-based perspectives is that they constitute a conceptual link between sociolinguistics and psycholinguistics (Backus, 2020). If speakers use specific language forms (and specific languages) in distinct social contexts, their repeated use will be stored in their memory as more salient in that context. For example, imagine a guide who uses their L2 English on a daily basis to show tourists around a castle but rarely uses English anywhere else. Such a person will likely associate their English strongly with the context of guided tours, with specific vocabulary about architecture and history, and with speaking to foreign visitors. The conceptualisation of the construction as a multidimensional unit allows usage-based approaches to capture English as stored in the mind of the castle guide as an emergent phenomenon resulting from the confluence of social, contextual, and cognitive factors. Thus, conceptualising language through constructions allows for theoretically rooted predictions that emphasise the need to quantify how frequently language instantiations or whole language systems are used in specific contexts or for specific purposes (Ellis – Wulff, 2020). Interestingly, current research increasingly acknowledges the need to account for bilingual speakers’ social and contextual realities to understand the circumstances under which bilingualism impacts our cognitive processes (Navarro-Torres et al., 2021; Grosjean, 2015).

The various interfaces through which constructions are defined also have implications for the dynamicity of the cognitive, social, and neurological processes put in place to use two languages (Ellis, 2005). In various communicative situations and for different purposes, one also needs to employ different mixtures of cognitive mechanisms to learn and use their language(s) (Wulff, 2021). From a usage-based perspective, all human beings have access to the same repertoire of cognitive mechanisms. However, everyone draws on these cognitive mechanisms in different proportions depending on their individual needs (Wulff, 2021). This resonates strongly with an emergent hypothesis that has been argued for in the bilingualism literature.
the control for activation of two languages is not subserved by unique cognitive processes. Rather, general cognitive skills will be recruited in different proportions due to the specific mix of contextual factors, language use patterns, and individual experiences (Navarro-Torres et al., 2021).

The intrinsic interrelatedness of the language system and general cognition implies that there is a two-way relationship between language and cognition (Zlatev – Blomberg, 2015). Even though the notion of interrelatedness of general cognition and language representation is strongly rooted in usage-based approaches (Backus, 2020), usage-based frameworks are more often used to explain language representations in our cognition rather than to focus on how our cognitive processes change by dealing with a language (or languages). Nevertheless, the idea that habitual patterns of language use modulate our cognition should not be surprising: while cognitive processes shape language instantiations, engagement in specific language behaviours (i.e., usage-based patterns) also likely shapes our cognition. Such a view could help us address one of the key questions in the field of bilingualism: How does using more than one language on a daily basis modulate our cognitive processes?

A single factor cannot explain cognitive plasticity in bilinguals. Bilingual language use constitutes a complex cognitive and social experience. Therefore, it is intriguing to view the existing evidence through the lens of usage-based approaches, which emphasise the complexity and adaptability of human cognition while trying to identify systematicities in the observed patterns. Even though the literature on bilingualism effects on cognitive processes does not always make an explicit appeal to usage-based theories, it often arrives at an interpretation of results that is highly consistent with this framework, as further discussed in the following sections.

3 Effects of bilingualism on domain-general cognitive processes

Even a limited knowledge and use of additional languages brings aspects of a complex life-long experience that requires managing several languages in one mind in various social environments. Importantly, one of the critical discoveries concerning bilingualism is that the languages a bilingual knows are both active, even if they intend to use only one of them (Kroll et al., 2012; Marian – Spivey, 2003). This comes with cognitive challenges, and the daily handling of two languages is hypothesised to result in ‘training’ and potential enhancement of executive functions (Bialystok et al., 2012). Crucially, these cognitive processes are assumed to be domain-general, that is, they are used across many activities beyond language use (Costa et al., 2009).

In their influential model, Miyake and colleagues distinguish inhibition, switching, and monitoring and updating as the three types of executive functions (Miyake – Friedman, 2012). Previous studies have presented behavioural evidence for the
strengthening of inhibitory control in bilinguals compared to monolinguals in a variety of inhibitory control tasks such as the Simon task (Martin-Rhee – Bialystok, 2008), the Stroop task (Bialystok et al., 2008) or the flanker task (Eben – Declerck, 2019). These tasks share the presence of congruent trials (trials where target stimuli are accompanied by informational cues which favour the target response) and incongruent trials (trials where the accompanying informational cues conflict with the correct response). For example, in the flanker task, which measures inhibitory control (Eriksen – Eriksen, 1974), the stimuli are typically series of five arrows. One of the arrows (generally the middle one) is the target stimulus, and participants need to indicate the direction of this arrow by pressing a corresponding button. In congruent trials, all the arrows point in the same direction as the target (→→→→→ or ←←←←←). In the incongruent trials, the accompanying (i.e., flanking) arrows point in the direction opposite to the target (→←→←→ or ←→←→←). The expected difference in reaction time before pressing the correct button between congruent and incongruent trials, as well as the difference in accuracy scores in pressing the correct button, is referred to as to the flanker effect, or the conflict effect (Eriksen – Eriksen, 1974). In the context of the flanker task and other similar executive control tasks (i.e., Simon or Stroop task), smaller conflict effects are traditionally interpreted to reflect an increased ability to inhibit unwanted information and resolve conflict.

In several studies, bilinguals have been found to have smaller conflict effects than monolinguals, which has been interpreted as evidence that bilinguals outperform monolinguals in cognitive conflict resolution and inhibition (Bialystok et al., 2004; Costa et al., 2008). Several other studies presented evidence suggesting that bilinguals are generally faster in both congruent and incongruent trials than monolinguals (Costa et al., 2008; Martin-Rhee – Bialystok, 2008). As there is no misleading information to be inhibited in the congruent condition, being faster at these trials cannot be linked to enhancement in inhibition (Martin-Rhee – Bialystok, 2008).

Another strand of research further differentiated between executive functions, specifically between monitoring and inhibition, by manipulating the proportion of congruent and incongruent trials in executive control tasks. In this view, an equiprobable proportion of congruent and incongruent trials (50% and 50%) is assumed to tap into monitoring skills, due to the assumption that the possible advantage in this condition stems from a constant readiness to monitor the situation and to react accordingly. By contrast, in the case of a highly disproportional representation of congruent trials, the rare occurrence of conflict trials prompts participants to relax their

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2 Note that the list of tasks used is far from exhaustive and was selected purely for illustration purposes. For further information on executive function and the tasks used see Morra et al. (2018).
monitoring skills and rather to rely on inhibitory control on a moment-to-moment basis (Kałamała et al., 2018). A study using both variations in a flanker task revealed that bilinguals had overall shorter reaction times than monolinguals only in the high monitoring condition (50/50 trial type split), which was interpreted as an indication that bilinguals have a monitoring advantage rather than a conflict resolution advantage (Costa et al., 2009).

The distinction between inhibition and monitoring largely aligns with the proposition of the Dual Mechanisms of Control Framework (DMC), which uses the terms proactive and reactive control (Braver, 2012). A proactive control strategy resembles monitoring and refers to active preparation for a conflict in advance through an active reminder of the goal of the task. Reactive control involves the suppression (inhibition) of a prepotent response in reaction to a stimulus after it is presented (Mäki-Marttunen et al., 2019).

Existing reviews on proactive and reactive control in bilinguals and monolinguals state that bilingualism appears to have more consistent effects on proactive control processes than on reactive ones (Bialystok et al., 2012; Declerck, 2020). A different conclusion was drawn by Hilchey et al. (2015), who did not find support for the proactive control advantage in bilinguals. Overall, these findings contribute to the controversy about the overall robustness of results suggesting that bilingualism confers benefits on executive functioning (Lehtonen et al., 2018; Paap, 2019). Namely, the findings highlight that cognitive differences between bilinguals and monolinguals do not emerge consistently and differ in the type of executive control investigated. Adding to the controversy, a number of studies on the modulation of cognitive processes in bilinguals compared to monolinguals have also reported negative or null results regarding the effects of bilingualism on cognition (Kirk et al., 2014; Paap et al., 2016; 2017; von Bastian et al., 2016). It is possible that these discrepancies are the result of differences in the ways in which bilingualism has been operationalised. In turn, it has been suggested that binary comparisons between bilinguals and monolinguals are insufficient to reveal specific effects of bilingualism on cognition (Luk – Bialystok, 2013).

4 Bilinguals vs. monolinguals: Issues of group comparisons

Binary comparisons of bilinguals with monolinguals presuppose that the mere fact that someone speaks two languages (as opposed to someone who does not) is deterministic and stable enough to distinguish the two groups based on general cognitive processes which are necessary to control for two language systems (Leivada et al., 2021). In fact, however, the general cognitive processes used to control for two languages are far from stable in bilinguals themselves. In reality, bilinguals differ vastly from each other, for instance in terms of the timing, purposes, intensity, and
quality of their bilingual language use across their lifespan (Beatty-Martínez – Dussias, 2018; Kroll et al., 2015; Pot et al., 2018). By way of example, an interpreter uses both languages under very different circumstances compared to a person who uses a second language to communicate with their partner and in-laws. The cognitive challenge and therefore the cognitive processes needed to handle two languages would be very different in these two examples. Thus, it is reasonable to expect that the cognitive consequences of bilingualism in interpreters will differ from those in a person who does not use their two languages in a professional capacity but only for everyday conversations. Yet, the individuals in both of these examples could be referred to as bilinguals and as such could be included in the same sample in a study which conceptualises bilingualism as a binary variable.

Monolinguals are not a monolithic group either. Some monolinguals label themselves this way even though they have some knowledge of a second language (Castro et al., 2022). Moreover, even in the genuine absence of any second language abilities, neurocognitive differences among monolinguals may still arise on the basis of the linguistic diversity in the environment they inhabit (Bice – Kroll, 2019). For these reasons, Leivada et al. (2021) and Bak (2016) suggest we need to move forward by focusing on individual experiences within bilingual groups to determine under what circumstances (if any) and to what extent bilingualism affects the mind. An important part of this advancement is the need to assess bilingual-related factors as continuous variables, rather than categorical ones (Luk – Bialystok, 2013), and to focus on the variability within bilinguals themselves with a view to identifying bilingual phenotypes (Navarro-Torres et al., 2021).

The next section discusses some of the individual bilingual factors which have already been studied with respect to their effects on executive function. The focus will lie predominantly on studies which treated bilingual experiences as continuous variables, in line with the prevailing opinion on how the field should advance.

5 Individual bilingual factors as possible modulators of executive functions

5.1 Age of language acquisition

Age of acquisition is a variable that is relevant for executive control because there is some evidence that the earlier a person starts acquiring a second language, the greater the impact on executive control due to the relatively longer training of the ability to manage two languages (de Bruin, 2019). This has been tested in studies

3 Knowledge of more than two languages (i.e., multilingualism) could have additional effects on cognition, which can also be qualitatively different from those observed in bilinguals (Quinteros Baumgart – Billick, 2018). For a review see Dewaele (2015).
that investigated differences in executive functions, either between early and late bilinguals (i.e., bilinguals who acquired both languages during their early childhood, typically through exposure, or later in life, often through formal language instruction) or using age of acquisition as a continuous variable. Some of these studies showed that early bilingual individuals performed better than late bilinguals on executive function tasks (Al-shujairi et al., 2015; Kapa – Colombo, 2013), and that earlier age of acquisition was related to a smaller conflict effect on an inhibitory control task (Soveri et al., 2011). This invited the view that in late bilinguals, the first language is more consolidated, making it harder to inhibit. It has also been suggested that late bilingualism might better train inhibitory control, whereas early bilingualism might result in more training in switching (Bak et al., 2014) or conflict monitoring (Tao et al., 2011). At the same time, another study found that early and late bilinguals performed similarly on an attention task (Pelham – Abrams, 2014). It is particularly noteworthy that age of acquisition did not emerge consistently as a significant continuous predictor of performance on a variety of executive function tasks (von Bastian et al., 2016).

The contradictory findings with respect to group differences could be further ascribed to the ambiguous cut off points for deciding which bilinguals qualify as early or late bilinguals across studies (de Bruin, 2019). Moreover, the onset of language acquisition does not provide information about involvement of cognitive control processes during the course of bilingual language acquisition and use, which brings into question the use of age of acquisition as a predictor of cognitive modulations (Leivada et al., 2021). Finally, age of acquisition is often confounded with another factor: language proficiency.

5.2 Language proficiency

It has been proposed that high proficiency in two languages is at least in part an outcome of extensive experience in controlling the activation of the mother tongue (Kroll et al., 2021), which justifies a link between proficiency and cognition. In line with this view, Singh and Mishra (2012) showed that bilingual children with a higher command of the second language performed better in terms of inhibitory and monitoring skills on an oculomotor version of the Stroop task, in which participants respond through their eye-movements by simply looking at the picture depicting their response. However, other studies with younger and older adults did not report any significant effects of language proficiency on cognition (Mishra et al., 2019; von Bastian et al., 2016).

When assessing language proficiency, one often compares the individual level of mastery of a second language with the standard form of that language. An argument against this view of language proficiency as a prominent factor modulating
cognitive control is that if any cognitive effects stem from the competition of language systems in one’s mind, the level of competition is not solely dependent on how well the internalized language resembles the standard version of that language (Leivada et al., 2021). On this note, Valian (2015) points out that if language proficiency had a prominent role in modulating cognitive capacities, interpreters, who are exceptionally proficient, should consistently outperform other bilinguals. This is often not the case, however, as will become clear in the following section.

A more plausible explanation for the effects of language proficiency on cognition can be found if this variable is considered as a proxy for language use, based on the assumption that if someone achieved high proficiency in their L2, they must have engaged with the second language often, or intensely.

Overall, the effects of language proficiency on cognitive control, whether they can be ascribed to this variable alone or to its confounds, remain unclear. Therefore, studies which do not primarily focus on effects of proficiency on cognition should likely control for this variable in their designs.

5.3 Professional bilingual experiences: interpreting and translating practices

Interpreters and translators are (either early or late) bilinguals with a high proficiency in both of their languages. However, these qualities do not make them distinct from a variety of other bilinguals. Rather, the factors which distinguish translators and interpreters from other bilinguals as well as each other emerge when considering how professionals regulate their languages on a daily basis in their jobs (Henrard – Van Daele, 2017). In other words, the differences between these groups likely pertain to specific usage-based patterns.

Interpreters need to keep both languages strictly separated to allow for fluent monolingual production while, sometimes simultaneously, listening to a stream of speech in the other language. This behaviour has been assumed to require superior cognitive control and working memory (i.e., a type of short-term memory allowing us to keep in mind short stretches of information for an immediate use during processing), in no small part due to the immense time-pressure under which interpreters need to operate (Yudes et al., 2011). Translators do not experience such time-pressure, nor do they need to deal with both languages simultaneously during language production and comprehension. Nevertheless, their work routine consists of constant switching between languages as they read and produce a translation in a limited time frame. They also need to avoid interference and to make sure that the translated text complies with the formal standards of the target language and that it conveys the semantic and aesthetic message contained in the source text (Liparini Campos, 2015). It should be clear that professional bilingual practices cannot be easily conflated with experiential phenotypes of non-professional bilingual groups using mainstream bilingualism-related factors.
One possible view of the cognitive control processes underlying interpreting and translating practices is aligned with the theoretical assumption of usage-based approaches: the cognitive processes are not qualitatively different from those used by non-professional bilinguals to regulate their language use. The only difference would then be that professional bilinguals use these processes more intensely (Babcock – Vallesi, 2017; Wulff, 2021). Indeed, several studies offer indirect supporting evidence for this view (Becker et al., 2016; Henrard – Van Daele, 2017; Woumans et al., 2015). For example, interpreters outperformed bilinguals and monolinguals on an inhibitory task (Simon task) and an attention task (Attention Network test; ANT) (Woumans et al., 2015). Interpreters were also found to have an advantage over translators on a switching task as well as a dual task, which taps into the ability to carry out two tasks simultaneously (Becker et al., 2016). By contrast, other studies showed that interpreters did not perform better on the Simon task and ANT than balanced bilinguals (Woumans et al., 2015), nor did they show an advantage in conflict resolution and a switching advantage compared to matched multilinguals (Babcock – Vallesi, 2017). Some studies even failed to find an inhibitory advantage in interpreters compared to monolinguals (Van der Linden et al., 2018; Yudes et al., 2011).

One key reason for these discrepant findings could be that the studies reviewed above use bilingual groups rather than assessment of bilingual experiences on a continuum. As mentioned earlier, such comparisons have important limitations, as one can inadvertently sample substantially heterogenous participants within one group (Soveri et al., 2011). Careful consideration of specific habitual use practices in these groups could illuminate the sources of cognitive plasticity in professional bilinguals.

5.4 Interactional context

The interactional context in which bilinguals learn and use their languages is recognised to have an impact on bilingual language control. This claim stems from the assumption that some environments encourage or discourage specific language use. This idea is central to the Adaptive Control Hypothesis (ACH) (Green – Abutalebi, 2013) and has also been more explicitly linked to usage-based (experience-based) approaches (Beatty-Martínez – Dussias, 2018).

The ACH is a framework for depicting how various social environments may lead bilinguals to use different cognitive control strategies such as goal maintenance, conflict monitoring (registering several possible, yet incompatible responses), interference suppression (ignoring less relevant but often more salient information or language), and response inhibition (see also reactive inhibition above). Highlighting the context of language learning fits the idea posited by usage-based approaches that specific socio-linguistic circumstances impact our habitual practices, which in turn also impact our cognitive processes (Beatty-Martínez et al., 2019; Beatty-Martínez –
Dussias, 2018; Backus, 2020). The ACH distinguishes between three different interactional contexts: (i) the single-language context, where only one language is used in one environment and another one in another environment; (ii) the dual-language context, in which both languages are used depending on the topics, situations or speakers, and where code-switching can occur, but usually only between sentences; and (iii) the dense codeswitching context, which refers to environments where bilinguals can alternate freely between languages and also mix them within one sentence.

These contexts differ in terms of the language control capacities they require. According to the ACH, the dual-language context poses the highest demands on conflict resolution and interference suppression, as one of the languages should be suppressed completely when the other one is used. Goal maintenance is important in this context due to speakers’ need to establish and maintain the use of the language that is appropriate to the situation. Similarly, a bilingual who operates mostly in single language contexts needs to keep using the same language and suppressing their other language. However, for a bilingual in the single language context, the maintenance of the target language and the interference of the other one is less cognitively demanding than in the dual language context, because the two languages are usually spoken in distinct environments. The dense code-switching context is posited not to trigger goal maintenance or conflict monitoring and interference control processes. The employment of these control processes stems from the competitive relationship between two languages, whereas during dense code-switching, the languages are in a cooperative relationship.

Many studies adopted the ACH framework to study the impact of the participants’ interactional context on cognitive control. Whereas some studies have confirmed effects of interactional contexts on cognitive control as proposed by the ACH (Beatty-Martínez et al., 2019; Hartanto – Yang, 2016), others have revealed more complicated patterns. For example, Ooi et al. (2018) compared conflict resolution performance of bilinguals in dense code-switching contexts among communities in Singapore and bilinguals in single-language contexts in Scotland. The authors used the ANT, among other measures (Fan et al., 2002). Their results revealed that bilinguals in dense code-switching contexts outperformed the single-language context bilinguals in conflict resolution. These results contradict the prediction of the ACH that dense code-switching contexts should not lead to an advantage in conflict resolution.

A possible reason for this discrepancy may stem from the fact that Ooi et al. (2018) distinguished their bilingual groups based on the environments they lived in. It is likely that code-switching is more prevalent among bilinguals in Singapore than among bilinguals in Edinburgh, based on studies of these linguistic environments (Xie – Cavallaro, 2016; Lauchlan et al., 2013). However, such an approach may be
insensitive to more subtle differences between individual language practices within each group, as suggested by researchers working from the usage-based perspective, who suggest that socio-linguistic reality and concrete linguistic realisation (i.e., form) are interlinked (Hakimov – Backus, 2021). In this light, studying how both of these aspects of language affect cognitive control might be a way towards reconciliation of discrepant findings. These concerns appear justifiable if one takes into consideration that code-switching occurs in various qualitatively distinct forms that pose different demands on cognitive control (Hofweber et al., 2019).

5.5 Habitual code-switching patterns

As could be derived from the discussion on the ACH, a possible distinguishing factor of code-switching patterns is whether switches occur between two sentences (intersentential) or within a single sentence (intrasentential). A framework devised by Muysken (2013) further distinguishes among three intrasentential code-switching types based on the patterns of how lexical and grammatical units from two languages are embedded in a single sentence, as illustrated in Table 1.

<table>
<thead>
<tr>
<th>Code-switching type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternation</td>
<td><em>He went home vyzvednout nějaké oblečení.</em>&lt;br&gt;'He went home to pick up some clothes.'</td>
</tr>
<tr>
<td>Insertion</td>
<td><em>Říkali nám, že prý můžeš dispute tvůj result.</em>&lt;br&gt;‘They told us that you can allegedly dispute your result.’</td>
</tr>
<tr>
<td>Dense code-switching</td>
<td><em>Jsem transporter and I’m a dodávka driver, který drive a van.</em>&lt;br&gt;‘I am a transporter and I’m a van driver who drives a van.’</td>
</tr>
</tbody>
</table>

Table 1: Code-switching types according to Muysken (2000) illustrated with authentic Czech-English code-switching examples from social media conversations among Czech students at the University of Reading and one example of dense code-switching from Macedonian (Hlavac, 2016). In the alternation example the language stretches appear to be relatively independent of each other structurally. It would be possible to divide the sentence into one entirely Czech and one entirely English part, which hints at a high level of separation of both languages. The insertion example documents lexical items from one language (English: *dispute*) inserted into the grammatical structure of Czech. In the dense code-switching example, both content and function words are taken from both languages. Furthermore, the relative pronoun is taken from Czech and links two English words. This suggests a high level of co-activation of both languages as the language codes are interwoven on the lexical as well as the syntactic level.
It has been assumed that these different types of code-switching employ different cognitive processes. In her Inhibitory Continuum Model (ICM), Treffers-Daller (2009) suggested that cognitive control processes are recruited in different ways for different forms of intrasentential code-switching. She hypothesised that intrasentential code-switches can be positioned on a continuum according to the level of separation between the languages and posits a positive relationship between separation and the level of inhibitory control required to enable the switch. To explain the differences in cognitive control, one needs to consider the length of time during which inhibition is needed to suppress the unwanted language. With alternation, one of the languages needs to be suppressed for longer language stretches than with insertion. In contrast, during dense code-switching, both languages are expected to work in cooperation to give rise to highly intermixed sentences. This suggests that general cognitive control processes will be recruited to different degrees in bilinguals who differ in the code-switching patterns they use.

Indeed, empirical studies on the link between specific code-switching patterns and cognitive control performance provide support for the notion that habitual code-switchers are better at those aspects of cognitive control that are trained by their code-switching behaviour (Hofweber et al., 2019; Hofweber et al., 2020a; Treffers-Daller et al., 2020). Such findings further highlight the need to consider the code-switching types as modulators of executive functions.

In the light of the usage-based perspective, it is possible to expect that the effects of engagement in concrete linguistic forms extend to other types of linguistic phenomena than code-switching. However, code-switching might be a potent linguistic behaviour in determining the impact of specific language forms on our cognition. Such thoughts are reinforced by a recent study which showed that habitual use of linguistically distinguishable code-switching types leaves measurable marks on our brain structure (Korenar et al., 2022).

5.6 Proportionality and diversity of language use
The individuality of the bilingual experience is associated with individuals’ needs and their use of languages. In this respect, one straightforward measure that could predict cognitive control demands is the frequency of use of each language. Yamashiki et al. (2018) report that more frequent use of the second language was related to faster inhibition of distracting information in an attention task, suggesting that high frequency of use of both languages requires higher degrees of inhibitory control. These findings corroborate the view that the frequency of engagement with specific language instantiations is an important modulator of cognitive processes, compatible with usage-based frameworks.

Grosjean (2015) points out that linguistic needs could be domain-specific as bilinguals acquire and use different languages for different purposes, which is in line
with the function component of constructions within usage-based approaches. Grosjean (2015) proposed to quantify the degree to which some topics and activities are used in both, or only in one, of the languages, hypothesising that this has cognitive consequences for the regulation of both languages. A diverse, more interchangeable use of both languages is assumed to trigger higher uncertainty as to what language should be used. The social diversity in bilingual language use can be captured by the measure of entropy (Gullifer – Titone, 2020). If a bilingual uses both languages in the same situations (high entropy, i.e., low predictability), their cognitive system needs to be prepared to switch between the languages and, thus, inhibit one of the languages very often, prompting reliance on proactive control. By contrast, bilinguals that show a clear separation of the situations in which they use L1 from the ones in which they use L2 (low entropy, i.e., high predictability) are more likely to rely on reactive inhibition (Hofweber et al., 2020b). Using the measure of entropy as a predictor, Gullifer and Titone (2021) report that high entropy language use was indeed linked to better performance on a flanker task variation involving proactive control, with low entropy language use relating to more efficient reactive inhibition.

6 Discussion
On the face of it, it can seem that the question of what effects bilingualism has on cognition is hard to answer. However, it is important to realise that such a broad framing of the question does little justice to the rich characterisation of bilingual factors which have been established. In fact, it is largely not the aim of studies on individual elements of bilingual experiences to pinpoint the overall effect of bilingualism on cognition. Rather, they intend to identify which bilingual experiences and individual differences influence cognition in similar ways, giving rise to meaningful and consistent effects (Navarro-Torres et al., 2021). In other words, the questions asked in the literature reviewed here are often focused on specific bilingual factors and their effects on cognition. Therefore, observed negative results should be interpreted in light of the question asked, rather than extrapolated to more general claims that effects of bilingualism are non-existent.

Although the bilingual factors under study might be concrete and specific, they should not be considered in isolation, as they interact with each other and with other variables. Following the hypotheses proposed by usage-based approaches, the interrelatedness between language and cognition pertains to all aspects of language, such as the linguistic form and meaning, and the purpose with which we use language. Therefore, it is necessary to study bilingual phenomena that relate to all these language components. As pointed out above, for example, proficiency and age of acquisition interact. Similarly, even though interpreters and translators have specific modi operandi in their jobs, individuals within these groups also differ from each
other in terms of proficiency or frequency with which they use each language. Such an interaction of factors constitutes a scientific challenge, which has been risen up to by devising more holistic measures and indicators tapping into an array of interrelated factors, such as entropy or interactional contexts which bilinguals inhabit. Interestingly, such a holistic approach aligns with the idea that particularities of language use in various contexts can help us grasp the effects on bilinguals’ cognition in more detail. Moreover, such a view resonates with the usage-based insight that cognitive processes put in place to deal with the activation of more languages arise from the interplay of linguistic forms, meanings, purposes of language use, and bilinguals’ socio-linguistic reality (Bybee, 2010; Backus, 2020).

However, it is necessary to keep advancing our understanding of bilingual effects on both levels: on the broader, holistic level, but also on the level of specific, individual bilingual factors. To this end, the usage-based approach might be an especially fruitful tool in linking various language components with each other to study their combined effects on cognition in bilinguals. For example, the impact of specific code-switching types (i.e., specific linguistic forms) on cognition in various interactional contexts (i.e., sociolinguistic reality) can help us better understand the range of bilingual behaviours that typically occur in the given socio-cultural environment. Such knowledge can inform us on how to classify bilinguals into groups with behavioural profiles in which comparable adaptive changes induced by their behaviours occur.

To conclude, we have revisited the literature on the effects of bilingualism on cognition, focusing on some of the most prominent approaches and bilingual variables traditionally used in the field. The discussion on the impact of bilingualism on cognitive processes is still ongoing. The field proposes several ways to deal with the controversy, including moving away from group comparisons between bilinguals and monolinguals. Furthermore, traditionally used bilingual variables (i.e., language proficiency, age of onset acquisition) may fail to reveal stable effects on cognition because of their insensitivity to the actual usage practices and purposes for which bilinguals learn and use their languages. Such logic is then rooted in the assumption that it is the usage and exposure to the second language that should be studied as the key to reconciliation of bilingualism effects on our cognition.

A considerable number of studies have not considered bilingualism as a set of experiences when examining its effects on cognitive processes. Viewing such variables through the prism of usage-based approaches appears a promising avenue for future research, as has been argued in previous studies and discussed in this article.

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4 For such a characterisation of bilinguals based on their habitual community practices, the term bilingual phenotyping has been used (Navarro-Torres et al., 2021).
Such an approach allows for comparisons of earlier studies with more recent ones, which have been more explicitly anchored in a usage-based perspective.

We note that we have discussed usage-based approaches broadly here because our primary goal was not to devise a theory on how languages are represented in our cognition. Instead, we attempted to introduce a reverse perspective in which usage-based frameworks serve as a prism through which we can effectively explain the cognitive consequences of bilingualism. We proceeded from the assumption that if language use patterns can reveal how language is represented in our cognition, it should also be possible to explain cognitive modulations based on the description of language use patterns. Putting the existing findings in the context of this framework highlights that cognitive plasticity induced by bilingualism depends on a complex interplay of social, contextual, and language-based factors. Notably, according to usage-based approaches, the plasticity of cognitive processes can be explained by insights into usage and frequency on the level of multidimensional constructions. Such a view might serve as an inspiration for bilingualism research when building a comprehensive theory that will account for the complexity of bilingual experiences from which arise systematic effects of bilingualism on cognition.

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Jedna mysl, dva jazyky: vliv bilingvismu na kognici z pohledu usage-based přístupů

Bilingvismus je spojován se změnami v kognitivních procesech, a to jak v procesech zodpovědných za jazykové zpracování, tak v doménově obecné kognici. Zůstává však předmětem diskuse, jak silné a stabilní účinky bilingvismu na kognici jsou. Rovněž zůstává nejasné, jaké aspekty bilingvismu jsou primárním zdrojem plasticity kognitivních procesů. Tento článek nabízí výběrový přehled literatury o bilingvismu a kognici a rozebírá existující studie zkoumající zdroje kognitivní plasticity u bilingvních mluvčích z pohledu usage-based přístupů. Zaměřujeme se na roli prominentních bilingvních
faktorů, jakými jsou úroveň znalostí jazyka, věk osvojování jazyka, míra střídání kódů, ale také proporcionalita používání jazyků. Tvrdíme, že literatura o vlivu dvojjazyčnosti na kognici se z části vypořádává s kontroverzemi tím, že nahlíží na bilingvismus perspektivou usage-based přístupů, i když spojení s tímto vědeckým rámcem není vždy výslovně zmiňováno. Zasazení bilingvních faktorů do kontextu usage-based přístupů může nabídnout silně cesty vpřed a zároveň umožnit srovnání stávajících studií o bilingvismu s novějšími studiemi, které jsou ukotveny v usage-based perspektivě explicitněji.

University of Amsterdam
Spuistraat 134, 1012 VB Amsterdam, The Netherlands
m.korenar@uva.nl

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