Cognitive Effects of Bilingualism: How Linguistic Experience Leads to Cognitive Change

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Bilinguals must have a mechanism for controlling attention to their two language systems in order to achieve fluent performance in each language without intrusions from the other. This paper examines the evidence that the experience of controlling attention to two languages boosts the development of executive control processes in childhood for bilinguals, sustains cognitive control advantages for bilinguals through adulthood and protects bilingual older adults from the decline of these processes with ageing. Future research with bilingualism should explore these effects in a broader and more multidisciplinary context in order to provide a more detailed understanding of the functioning of the bilingual mind.

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If we could examine the linguistic representations of a native monolingual speaker of any language, we would find a structured system of linguistic knowledge connecting syntactic structure, semantic intent, phonological realisation, and probably aspects of pragmatic and nonlinguistic constraints that define the regularities of that language. Regardless of the linguistic theory to which one ascribes, linguistic knowledge is represented and structured, however metaphorical the interpretation of representation may be. Consider now a bilingual speaker whose fluency in the two languages is relatively equivalent and whose use of both of them is routine. This bilingual speaker, therefore, has two representational systems, both rich in detail and structure that underlie language production. It is immediately apparent that bilinguals face a problem that is logically irrelevant for monolinguals: how is language production confined to the representational system for the relevant language, avoiding interference from the other system?

This problem of selecting between two potentially competing linguistic systems is inherently part of bilingual language use, no matter what type of linguistic theory is used to describe those systems. Following either formal models in which linguistic structure is conveyed through a set of abstract principles generated from universal grammar (e.g. Pinker, 1994) or functional models in which linguistic regularity is deduced from meaningful encounters (e.g. Tomasello, 1998), linguistic knowledge must still be represented, albeit in very different ways. Therefore, descriptions of how this selection problem is resolved can be addressed without making assumptions about alternative

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theoretical conceptions of linguistic structure and apply more broadly to descriptions of bilingual language use. Because bilinguals will necessarily have multiple linguistic representations to accommodate their knowledge of two languages, a fundamental divide between monolinguals and bilinguals is inevitable.

Another way of considering the alternative hypotheses regarding the structural organisation for two linguistic representations is in terms of their degree of overlap or convergence. Some models propose that the two languages are represented in a shared system (Francis, 1999; Klein *et al*., 1999), others postulate distinct representational spaces (Dehaene *et al*., 1997; Durgunoglu & Roediger, 1987), and still others present a more complex view in which factors like proficiency (Perani *et al*., 2003) or age of acquisition (Kim *et al*., 1997) intervene to determine the representational location. Again, these options have no bearing on the essential fact that the representational structure for language is different for monolinguals and bilinguals. This difference defines the central problem for bilingual language use: how does one confine language use to a single system when two fully elaborated linguistic systems are represented in the mind?

Considerable psycholinguistic evidence has demonstrated that the two representational systems for bilinguals are both active even when only one of these systems is being used (Grainger, 1993; Guttentag *et al*., 1984; Hermans *et al*., 1998; van Heuven *et al*., 1998). Activity, in this sense of availability, is a statement about language use and is tied neither to a particular linguistic theory nor to a specified representational location. In other words, the functional description for bilinguals is that there is access to two competing linguistic systems, although the structural description can take different forms in specifying the relation between those systems in their shared or individual localisation in the brain. Therefore, the implications that follow from this claim that both languages are active apply irrespective of theoretical orientation and require only evidence that this situation is an accurate description of bilingual functioning. The evidence supporting the claim has been amassed from research using a variety of tasks, including cross-language priming (Gollan *et al*., 1997), cross-language Stroop interference (Brauer, 1998; Chen & Ho, 1986), cross-language homograph recognition (Dijkstra *et al*., 1999) and cross-language picture naming (Hermans *et al*., 1998). In all these cases, the ability to perform in one of the two languages shows reliable interference effects from the other language, even though it is explicitly not relevant to performance on that task. These are some of the studies that support the important conclusion that the representational systems underlying both languages for bilingual speakers are constantly active and available during all language use activities.

With two active but competing systems capable of generating linguistic behaviour, bilinguals need a mechanism to control attention to the required system and ignore the system not currently in use. Because the two representational systems are by necessity so similar in that they present alternative means of expressing some underlying concept that must, at some level, be the same (Kroll & de Groot, 1997), they are inherently conflicting. In addition, a bilingual will frequently need to shift attention because the next linguistic encounter proceeds in the other language, so the previously

suppressed representation is now relevant. Therefore, rapid monitoring of the context and efficient switching between representations is also required for fluent performance in both languages. It is at this point that the premise regarding the integration of linguistic and cognitive systems is crucial, because with a fully integrated system, the problem of managing the competing linguistic representations can be handled by general cognitive processes. The processes necessary to control the two language systems for a bilingual – attention, inhibition, monitoring and switching – are all components of the executive function (Daniels *et al*., 2006). Therefore, the need to constantly use these processes in the management of two language systems may modify the development or operation of the executive function for bilinguals.

Three hypotheses follow from this proposal. The first is that bilingual children will develop control over executive processing earlier than monolinguals. The executive processes are the last cognitive ability to develop in young children, not being reliably available until children are about 5 years old and the frontal cortex has completed its growth (Diamond, 2002). The intense practice that comes from using these functions to control attention to two developing language systems may lead to precocious development of these executive abilities in bilingual children. The second hypothesis is that the boost provided to these functions in development is sustained through adulthood, making adult bilinguals more competent or more efficient in executing executive processing than their monolingual counterparts. Finally, the executive processes are the first abilities to decline with normal cognitive ageing, showing slower and less efficient control over these functions with age (McDowd & Shaw, 2000; Park, 2000; Rabbitt, 1965). The third hypothesis, therefore, is that lifelong experience and continued reliance on these processes for monitoring two language systems will delay their decline for older bilinguals. The evidence for each of these hypotheses will be examined in turn.

Development of Executive Processing

The primary methodological challenge to studying the development of executive functioning is to create tasks that distinguish between the role of the executive components and other cognitive abilities in the solution to specific problems. This is particularly important when the hypothesis is that participants who are otherwise equivalent in cognitive performance will differ in their development of executive processes. My earlier research that investigated the two processing components called analysis of representations and control of attention (Bialystok, 1993) provides a basis for distinguishing between the cognitive and executive aspects of thinking, and an extension of that work has formed the basis for a framework incorporating changes in cognitive abilities across the lifespan (Craik & Bialystok, 2006). The processes involved with analysis of representations are based on the structure and organisation of knowledge, while those underlying control of attention are responsible for the on-line allocation of resources to information. Thus, the processes included in control of attention are coterminous with the executive function. For this reason, research that has isolated children's development of control processes from representational processes is a source of evidence for

the hypothesis that executive processing develops earlier in one group than in another.

The first attempts to investigate the differential development of cognitive skills as a function of bilingualism began with the study of metalinguistic ability. If bilingualism were to influence any aspect of development for young children, it was most plausible that such effects would be found in the domain at the centre of the mechanism, namely, the language system. Evidence for differences between monolinguals and bilinguals in their ability to manipulate and reflect on structural aspects of language as a system would be plausible because of the difference in the language experience of children in these two groups. Research comparing monolinguals and bilinguals on metalinguistic tasks reported just such bilingual advantages (Galambos & Goldin-Meadow, 1990; Galambos & Hakuta, 1988; Ricciardelli, 1992). More precise evidence that traced that difference to some but not all underlying processes, however, contributed to both conceptions of language and models of cognition. This research used metalinguistic tasks investigating syntactic judgements of grammaticality (Bialystok, 1986a; Cromdal, 1999), concept of word (Bialystok, 1986b) and concept of meaning (Bialystok, 1988). In all these studies, versions of problems were created that required the same metalinguistic judgement but differed only in the presence of misleading or distracting information that needed to be ignored.

An example of this approach can be seen in the grammaticality judgement task (Bialystok, 1986a, 1988). Children are trained to decide whether a sentence is 'said the right way' (i.e. grammatical) or 'said the wrong way' (i.e. not grammatical) irrespective of its meaning. The children are persuaded that silliness is fine in this game, and they only have to decide if the sentence is said the right way. The ability to identify a grammatical error, such as in the sentence, 'Apples growed on trees', requires a representation of correct linguistic structure. In contrast, the ability to recognise that the grammar is correct in the sentence, 'Apples grow on noses', requires the ability to ignore the misleading anomaly in meaning and focus attention only on the form of the sentence. Thus, the first judgement reflects representational knowledge of linguistic structure and the second, attentional control to use that structure. Consistently, bilingual children have been shown to be more able than monolinguals to ignore the meaning and agree that the second sentence is correct but the two groups are equivalent in determining which of a set of meaningful sentences contain grammatical errors. Bilinguals, in other words, are superior to monolinguals in executive control of attention, although they are no different from monolinguals in their knowledge of the system.

The same pattern is found in tasks based on concepts of quantity. Two tasks that assess concepts of cardinal quantity show different patterns of response depending on the need for attention and inhibition to override a salient response. First, in the towers task, children need to decide which of two towers has more blocks in it when the towers are built out of different kinds of blocks, one being twice as large as the other. In half of the items, the taller tower has fewer blocks, but children are reminded on every trial to count the blocks to determine the response. The perceptual height of the tower is a powerful misleading cue that children need to override. Second, the sharing problem

requires children to divide a set of objects equally between two dolls by using a 'one-for-you and one-for-you' strategy and distributing an object to each doll on an alternating basis. Children then count the items in one set, agree that they are equal for the two dolls, and need to say (without counting) how many items the other doll has. Both tasks involve counting a small set of items and making a judgement about that quantity. Bilingual children, 4 and 5 years old, outperform monolinguals on the towers task but the two groups are the same on the sharing task (Bialystok & Codd, 1997).

Finally, the pattern emerges again in problem-solving tasks that involve neither print nor numerical quantities. In the dimensional change card sort task (Zelazo & Frye, 1997), children are required to sort coloured images first by one dimension (e.g. shape) and then by another (e.g. colour). The reliable finding is that young children find it extremely difficult to reclassify the pictures once they have already been sorted according to the first dimension. To revise the basis for the classification from the obsolete dimension to the new feature, children must ignore the previous dimension (shape) even though it continues to be perceptually present and salient, and focus attention instead on a different feature of the same stimulus (colour) in order to re-represent the stimulus in the new terms. These are all components of executive functioning because they involve intentional procedures for focusing attention when there is conflicting information, selecting relevant from irrelevant features, and establishing representations to classify the stimuli. In several studies, we have shown that bilingual children solve this problem more easily than comparable monolinguals (Bialystok, 1999; Bialystok & Martin, 2004).

In the research described above, tasks that did not contain misleading information were solved similarly by monolinguals and bilinguals. In addition, children in all these studies were assessed for such background abilities as working memory and, sometimes, conceptual understanding of the domain. These measures were always the same for children in both groups. However, monolinguals and bilinguals do not bring precisely the same background skills to these tasks. An area of consistent bilingual *disadvantage* is in receptive vocabulary: bilingual children score lower than monolinguals in each of the languages. This result has been replicated in almost every study that has compared monolingual and bilingual children in the preschool and sometimes early school years (Oller & Eilers, 2002). Weak competence in the language of schooling led Macnamara (1966) to caution that bilingual children were disadvantaged and performed more poorly in subjects such as mathematics as well in language skills. Based on the research available at the time, Macnamara concluded that there was no evidence that bilingualism handicapped children's computational ability for mechanical arithmetic but found that it did impair children's ability to solve mathematical word problems. His own large-scale study of English-speaking children in Irish language schools confirmed this pattern. He attributed the deficit to what he considered the inevitable language handicap that followed from bilingualism but did not discount the logical possibility that bilingualism itself was to blame. Mestre (1988), however, demonstrated that bilingual and monolingual children who were equated for language ability solved mathematical problems to exactly the

same level of competence, removing the interpretation that bilingualism itself was responsible for performance differences in this domain.

Across the various problems, the consistent pattern is that bilingual children develop the ability to control attention and ignore misleading information earlier than monolinguals, even when the two groups are operating with the same basic knowledge of the domain. This dissociation is the basis for the claim that bilingualism has a specific impact on the development of executive processing but no effect on basic cognitive performance. Bilingual children are no more intelligent or knowledgeable than their monolingual peers; instead, bilingual children have an enhanced ability to control the use of their knowledge in performance, especially where competing or distracting information must be resisted. The source of the advantage, on the present view, is the experience of controlling attention to the relevant language system in the face of competition from the other language, which is simultaneously active but irrelevant to the current language task. This experience boosts those control processes, making them more efficient for other uses, even nonlinguistic ones.

Differences in Stable Processing

The evidence from a variety of problem domains has demonstrated precocious development of several executive processes for bilingual children compared to their monolingual peers. All the problems used to detect these developmental differences, however, are simple tasks that all children eventually master. In the longer run, it may make no difference if children conquer these problems at age 4 or 5 years – all children eventually achieve mastery over these simple tasks and make the same developmental gains. A more stringent test of bilingual influences on cognition, therefore, would be evidence that precocious processing was sustained into adulthood. Do monolingual and bilingual adults have different levels of control over executive processes?

There is little research that investigates this possibility. This is not surprising for two reasons: conceptually, most interpretations of executive functioning are incompatible with the idea that these processes could be altered through experience, so there would be little motivation to search for the effect of different experiences on their function; methodologically, tasks that are used to assess executive functioning are rarely used to detect individual differences in performance.

An enduring premise in cognitive psychology has been that cortical organisation is stable, consolidating functions through development, associating those cognitive functions with neurological structures, and changing only in the efficiency with which those functions can be carried out. More recently, this assumption has been challenged, and researchers have demonstrated lifelong plasticity in the organisation of cortical functions (Reuter-Lorenz, 2002). The potential for change in the structure and function of basic cognitive processes leads to the possibility that these processes can be modified by experience. Posner and colleagues have been particularly explicit about the type of modification to executive function that can follow from experience and

training (Fan *et al*., 2003; Posner & Rothbart, 2000). In another example, Green and Bavelier (2003) compared participants who differed in how much time they spent playing video games on a set of commonly used tasks of attentional processing. Computer video games require high levels of controlled attentional processing; information flashes rapidly across a screen and arbitrarily connected responses must be executed to keep the game in play. Green and Bavelier found large significant advantages for video game players in performing these tasks compared to a comparable group of participants who were less practised in these games. In other words, a generalised effect of an experience improved the functioning of an executive process for tasks quite different from those encountered during the training or experience.

Just as playing video games boosts the ability to perform attention tasks because of the practice obtained in attentional processing, so might bilingualism boost the ability to perform certain executive tasks because of the practice obtained in using those processes to control attention to language systems.

Two studies have investigated this hypothesis. The first used the Simon task, a measure of stimulus-response compatibility that requires intentional processing and executive control to perform accurately. In the Simon task, participants learn a rule that connects each of two stimuli to a response key. For example, they are told to press the right key if they see a green square and the left key if they see a red square. Red and green squares are presented on the screen on either the right or left side of the display, and participants respond with the correct key as quickly as possible. When the stimulus position and response key are on opposite sides, such as a green square on the right side of the screen, it takes longer to respond to the colour of the stimulus. The reliable increment in response time to resolve the conflict between the position and response key is the Simon effect. Although there are many explanations for the Simon effect (Lu & Proctor, 1995), all of them entail controlled processing to resolve the conflict.

A group of 97 young adults, approximately half of whom were fully fluent lifelong bilinguals, performed the Simon task under different conditions (Bialystok, 2006). The manipulations altered the amount of conflict inherent in the task and the amount of monitoring and switching required to perform it. Conflict was manipulated through the use of two types of stimuli, coloured squares and directional arrows, each of which was the basis for a different task. For the squares task, the main challenge is to remember the arbitrary rule that associates each colour with a response key; for the arrows task, the main problem is to resolve the conflict between the spatial codes given by the direction of the arrow and its position. The rule is to press the key showing which way the arrow is pointing, so an arrow in the same screen position as its directional indication is easier than one in the opposite position. The difficulty is only in the conflict between these two cues, because there is no effort required to remember the mapping between the direction and the correct keys: right arrows press right, left arrows press left. Monitoring and switching were manipulated in both tasks by creating conditions that differed in the number of inter-trial switches that occurred in each block of trials. A switch trial was one in which the response was different from that required on the previous

trial. The need for frequent changes in response requires more vigilance and more monitoring, increasing the general processing demands. Evidence for the success of this manipulation and the accuracy of its interpretation is that blocks that contained many inter-trial switches took consistently longer to perform than comparable blocks that contained fewer inter-trial switches. There were few differences between the two language groups in their performance on these two tasks across the various conditions. The monolinguals and bilinguals were drawn from the same undergraduate university population, all were experienced computer users and all were comfortable with this type of task, which demanded fast and accurate responding. Nonetheless, bilinguals responded significantly faster than monolinguals in one condition: the difficult version of the arrows task in a block of trials with many inter-trial switches. This is the condition with the greatest burden on executive processing. The arrows stimuli are inherently more conflicting with the position than are the coloured squares, requiring higher levels of attentional control, and the high switch condition demands higher levels of monitoring and switching. This is the condition in which bilinguals demonstrated their superior control over executive processing.

The second example comes from a task based on the anti-saccade effect (Munoz *et al*., 1998; Roberts *et al*., 1994). Like the Simon task, the anti-saccade task measures the ability of participants to overcome a prepotent response by intentionally applying a rule. The anti-saccade effect requires participants to resist the automatic attention responses in which gaze is immediately directed to a flashing object and is influenced by the gaze direction of pictures of eyes in a schematic face on the screen (Friesen & Kingstone, 1998; Zorzi *et al*., 2003). These two cues for orienting saccades, namely, flashing targets and eye gaze direction, were incorporated into a task to compare the ability of monolinguals and bilinguals to overcome these cues when necessary and control attention to target locations (Bialystok *et al*., 2006).

There were two conditions of this experiment. In the first, called eyes straight, a schematic face appeared on the screen, then an interval followed, after which the eyes became coloured either red or green. If the eyes were green, then the participant had to press a response key on the same side of the display as a target asterisk that appeared half a second after the eye colour cue, and if the eyes were red, the required response was on the opposite side of the target. Thus, the green eyes signalled a pro-saccade condition because the flashing target automatically attracted attention to that side of the display and oriented the participant to the correct response key. These responses needed to be suppressed when the eyes were red so that the opposite response could be executed. The second condition was called gaze shift. The protocol was the same, except that the eyes also shifted direction to 'gaze' either left or right, looking either towards or away from the position in which the target would appear, when the colour cue appeared. This additional cue was intended to create the need for greater intentional resources to overcome a misleading directional cue in addition to the prepotent saccade in the anti-saccade condition. When the direction of eye gaze was away from the target in the green eye condition, for example, the incorrect response would be additionally reinforced. Thus, the most difficult combination was when green eyes looked

away from the target, misleading the participant to the opposite side, or when the red eyes looked *towards* the target, again directing attention to the incorrect response position.

There were 48 young adults, half of whom were bilingual, participating in the experiment. As in the Simon task, there were few differences between participants in the two groups. But also as in the Simon task, there was a reliable advantage for the bilinguals in the most difficult condition, namely, the anti-saccade condition of the gaze shift task where two cues needed to be suppressed in order to respond correctly. Specifically, the conditions in which bilinguals recorded faster response times than the monolinguals were in the gaze shift trials in which green eyes looked away from the target or red eyes looked towards the target. On these trials, bilinguals performed significantly faster than monolinguals, but on all other conditions, the two groups responded equivalently.

These two experiments show that there are few processing differences between monolingual and bilingual young adults on tasks usually used to measure executive control. In both cases, however, there were reliable bilingual advantages on the most difficult conditions, suggesting that normal functioning is handled equally well by both monolinguals and bilinguals, but the extra controlled effort required when processing demands increase are more easily met by bilinguals.

It is possible that monolinguals and bilinguals perform these tasks differently even when there is no measurable difference in reaction time. If the experience of bilingualism in fact modifies the structure and function of executive control, then it is possible that evidence for that modification is apparent in the organisation of the cortical centres responsible for these processes. We investigated that possibility by comparing 30 young adults, 20 of whom were bilingual, on a Simon task in which we obtained cortical images using magneto-encephalography (MEG) (Bialystok *et al*., 2005). The stimuli for this task were coloured squares, and as in the results of the Simon task reported above, there were few reliable differences in reaction time between monolinguals and bilinguals. In spite of this, however, there was a significant difference in the cortical regions associated with fast responding for each group. Participants in both groups relied on left frontal structures. Consistent with previous research of this type, monolinguals used regions traditionally associated with conflict resolution, including BA9, bordering the dorsolateral prefrontal cortex (e.g. Peterson *et al*., 2002). In contrast, the bilinguals used regions traditionally associated with language use, including BA45, Broca's area. Thus, the bilinguals solved this task by extending a highly practised set of structures not usually used for nonverbal attention tasks of this type. This shift in function is a consequence of the experience of using those centres routinely for the management of language systems. Moreover, this finding is consistent with an argument advanced by Novick *et al*. (2005) in which they demonstrate the role of Broca's area in a variety of tasks requiring conflict resolution, including nonverbal tasks. Their account of language processing together with their evidence for the role of Broca's area in resolving conflict is consistent with the findings that individuals with massive experience using these centres for managing language conflict (as in the conflict between the

two linguistic representations) will more likely use this area as well for managing conflict in a nonlinguistic task.

Protection from the Decline of Executive Processes

The cognitive functions responsible for effortful processing, including the executive functions of attention and inhibitory control, decline in speed and efficiency with normal healthy ageing (McDowd & Shaw, 2000 for review). The final hypothesis, then, is that the experience of lifelong bilingualism in which these processes are used regularly to control attention to two language systems bolsters those functions and reduces the speed or severity of their decline.

Evidence for this protective effect was obtained in two studies. The first used the Simon task, described above, and compared the performance of monolingual and bilingual adults between 30 and 80 years old (Bialystok *et al*., 2004). Between the ages of 30 and 60 years old, bilinguals maintained a consistent reaction time advantage compared to monolinguals of the same age. From 60 years old onward, participants in both groups began to slow down, showing significant increases in the time to respond to the task for each decade of age. The slowing down, however, was more rapid for monolinguals, so as age increased, the difference between the monolinguals and bilinguals increased as well. Bilingualism protected the bilinguals by reducing the rate in which these attentional processes declined.

The second study used the faces anti-saccade task described above (Bialystok *et al*., 2006). A group of 48 participants between 60 and 70 years old, half of whom were bilingual, completed the task in both the eyes straight and gaze shift conditions. As was found for the young adults (described above), monolinguals and bilinguals responded at the same rate when green eyes pointed straight ahead, that is, the simplest pro-saccade condition. Unlike the younger adults, however, older bilinguals were significantly faster than comparable monolinguals on the anti-saccade red eye condition in which the response had to be suppressed. The control required to resist responding with the congruent response key, even with no additional miscue from the direction of gaze, was handled more easily by older bilinguals. When the gaze direction was added in the more complex version of the task, bilinguals were faster than monolinguals in all conditions. The most difficult conditions required high levels of attention and inhibitory control to resist pressing the same side in the red eye trials and to ignore the misleading information from the eye gaze when it directed attention to the wrong side. The combination of these executive processes was handled better by older bilinguals than monolinguals, suggesting again that these functions had been protected by their experience.

Bilingualism and the Lifelong Trajectory of the Executive Function

The executive functions are basic to all cognitive life – they control attention, determine planning and categorising, and inhibit inappropriate responding. They are normally considered to reside in areas of the frontal cortex, a region of the brain that is the last to develop in childhood and the first

to deteriorate with ageing. Speculatively, these executive functions are recruited by bilinguals to control attention to the two languages systems in order to maintain fluent performance in one of them. The massive practice that is involved in that application leads to the hypothesis that these processes are bolstered for bilinguals, creating systems that are more durable, more efficient and more resilient. Thus, for bilinguals, control over the executive functions develops earlier in childhood and declines later in older adulthood.

The research reported in this paper provides evidence for a significant change in executive processing ability that can be traced to the effect of practice that follows from a specific experience. These results do not depend on the adoption of a particular linguistic theory that posits either autonomous linguistic rules and structures or general cognitive mechanisms, nor do they require that linguistic representations for two languages reside in shared or separate storage spaces. Instead, they indicate that bilingualism as a normal lifelong experience creates a context in which the executive processes for attentional control are employed routinely, and this use for language management has the felicitous benefit of boosting their function across other cognitive domains, even those that apparently have little connection to linguistic performance.

Bilingual children gain control of executive control functions earlier than monolinguals, bilingual adults have more executive resources available when executive demands become especially complex, and bilingual older adults show a less steep decline in the slowing down of these functions with age. What does this imply about the cognitive life of bilinguals? Are bilinguals more intelligent than monolinguals? Here it is important to distinguish between the boost to the executive resources and the complexity of the cognitive system that underlies intelligent behaviour. There is no evidence that bilinguals are in any measurable sense more intelligent than monolinguals. In some areas, particularly linguistic ones, bilinguals are handicapped, possibility because of the cost of maintaining two representational systems (Michael & Gollan, 2005). Thus, bilinguals perform less well than monolinguals on tasks requiring rapid generation of words, such as semantic fluency and picture naming (Gollan *et al*., 2002). Other processes that are foundational to intelligent behaviour, such as working memory, are also no different in monolinguals and bilinguals.

The direction indicated by this interpretation is that bilingual research needs to be more fully integrated into the investigation of other aspects of language and cognitive performance. The 'bilingualism' of an individual coexists with a constellation of other descriptions, including the age, cognitive level, specific language competence, and a variety of social and motivational factors that jointly determine the mental capacity and cognitive change that will follow. Research with bilingualism must begin to incorporate all these dimensions, involving as well the methods of cognitive psychology, neuroscience and linguistic theory.

The research so far reveals compelling evidence that bilinguals develop executive control earlier and maintain their ability to control those functions longer than monolinguals. Given the fundamental centrality of these executive processes to our everyday cognitive life, this is an altogether promising

outcome for bilinguals. A more complete description of the mental life of bilinguals awaits the completion of new and more integrative research.

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