

## **Cognitive Benefits of English as Second Language: A Meta-Analysis**

Jaba Varadwaj

*Research Scholar, Ravenshaw University, Cuttack, Odisha, India*

Keka Varadwaj

*Lecturer in Psychology, Banki College (Autonomous), Banki, Cuttack, Odisha, India,*

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**Abstract:** *Although early research on bilingualism warned it as detrimental to cognitive development, several subsequent studies reported on the positive cognitive consequences of bilingualism. Such studies included participants from children to adults from diverse language and cultural contexts. In many of those studies English is found to be mentioned as second language. To bring out a clear understanding about the cognitive benefits for second language English learners, a meta-analysis was carried on 32 studies involving 4161 participants. Data from the studies were extracted and analyzed using Hedge's 'g' as a standardized metric of effect size for group comparisons. Results indicate that bilingualism with English as second language, irrespective of the first language and participant's age / grade status, is positively associated with several cognitive outcomes. Cognitive skills found to have a progressive growth among the bilinguals from early to later grades are attentional control, working memory, metalinguistic awareness, and problem solving. However, evidence is not obtained about progressive growth in metacognitive skills and in symbolic representation and divergent thinking. Finally, the overall results point to the facts that bilingualism strongly influences attentional control, metalinguistic awareness, symbolic representation and divergent thinking and but has minimal influence on metacognitive and problem solving skills.*

**Key words:** *Cognitive benefits, Effect size, Hedge's 'g', Meta-analysis, Bilingualism.*

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### **I. Introduction**

Many studies have consistently reported the cognitive benefits of bilingualism. Some of the important benefits include higher control in attention, better performance in working memory, better awareness of metalinguistic and metacognitive skills, and also higher skills in symbolic reasoning, divergent thinking and problem solving. For example, Bialystok (2001a & 2001 b), reported that bilinguals have increased abilities in selective attention when there is competing or misleading information in the task. She observed that such control in the attention processes of the bilinguals arise from two sources; bilinguals' enhanced ability in analyzing their knowledge of language, and their greater control in language processing. She pointed out that this attentional competence among the bilinguals may be due to their need to differentiate between two languages. Since both the languages remain active during language processing, there is an attentional control for inhibition of one language so as to avoid intrusions into the language in operation. In some of her studies, Bialystok also observed that bilinguals showed more advanced understanding in their processing of words and in the development of the concept of a word which is due their focus in analyzing their knowledge of language.

There are two contrasting hypotheses about the relationship between bilingualism and working memory. First of all, the need to manage two languages concurrently could place greater demands on working memory. Hence, bilingualism is likely to impede the efficient processing of information in working memory because of the cognitive load imposed on it. Conversely, bilinguals' ability to inhibit one language while using the other; increases their efficiency of working memory capacity because working memory resources are properly managed through such inhibitory processing. For example, Engel (2002) reported that bilinguals have greater working memory capacity when the tasks require greater attentional control. Many studies have also pointed to the better meta-linguistic awareness of the bilinguals. Metalinguistic awareness refers to the ability to think about language. It is the explicit awareness about the linguistic structure and how they produce meaning. It is hypothesized that the experience of maintaining two different languages, allow bilinguals to develop an understanding of how language works. For example, bilinguals have two different words to describe the same concept which help them to develop an insight that words are arbitrary and only symbolically related to the concept. Similarly, when syntactic rules differ across languages, bilinguals become aware of the intrinsic characteristics of the syntax and therefore, develop meta-awareness about both the languages. In fact, majority

of studies have found that bilinguals, particularly those who are highly proficient in both languages, demonstrate greater metalinguistic awareness than their monolingual counterparts.

Metacognitive awareness refers to the knowledge about one's own cognitive processes. It refers to the process of learning the vocabulary, syntax, phonology, and morphology of language, as well as learning how to contextually use the knowledge. Many studies (i.e., Ransdell et al., 2006; Kemp, 2007) have reported that bilinguals have better metacognitive skills compared to monolinguals. Similarly, across a number of studies, bilinguals have shown enhanced skills in creative and divergent thinking and also in symbolic reasoning. In a meta-analytic review of 24 studies, Ricciardelli (1992) found that bilinguals outperformed monolinguals in 20 of the 24 studies showing a clear positive relationship between bilingualism and creativity or divergent thinking. Ricciardelli suggested that because bilinguals develop greater cognitive flexibility due to their ability of switching between two languages, they are better in abstract and symbolic reasoning. Further, bilinguals also show evidence of enhanced problem-solving skills, particularly on tasks requiring executive control such as planning, cognitive flexibility and rule acquisition (i.e., Baddeley, 1996, Bialystok, 1999, 2006). All these researchers suggested that the enhanced problem-solving ability of bilinguals is due to their cognitive flexibility. Because bilinguals have the capacity to choose between two languages, they develop more flexibility with respect to thinking that can be applied to solve problems.

### ***Rationale for the study***

Since Peal and Lambert's (1962) classical work, large numbers of studies have documented the positive cognitive benefits of bilingualism. However, the magnitude of these effects relating to different cognitive functions remains unclear. Even, some of those studies have shown that performance of the bilinguals is relatively impaired on some cognitive tasks. A few studies have also demonstrated mixed effects of bilingualism on performance of cognitive tasks. Therefore, the present research is an attempt to synthesize the results of thirty two important studies in the field of bilingual research on different cognitive outcomes of bilingualism. The meta-analysis addresses the following research questions.

### ***Objectives***

- (i) To compare the effect size of unilingual and bilingual difference on the benefited cognitive skills for the early grade children and later grade students and adults having learned English as second language.
- (ii) To examine the nature of development of these cognitive skills through effect size differences from childhood to later years among unilingual and L<sub>2</sub> English bilingual subjects.
- (iii) To compare the overall benefit to each of these cognitive skill in terms of effect size due to learning English as second language.

## **II. Method**

***Selection criteria:*** To capture relevant studies on the cognitive benefits of bilingualism, specific criteria for inclusion were used. Studies were deemed eligible if: (i) carried out on bilingual participants having English as second language; (ii) used any of kindergarten to post secondary children / students / adults as participants; (ii) used bilingual participants and control group of monolingual participants, and (iii) studies in which the measured outcomes were clearly reported and were in favor of the bilinguals. The outcome measures were several cognitive skills such as attentional control, working memory, metalinguistic awareness, metacognitive skills, symbolic representation and divergent thinking, and problem-solving.

***Calculation of effect size:*** The effect size of the mean differences was used as the standard measure for comparison of groups. Effect size is a standardized metric obtained by calculating the difference between the means of the experimental (bilingual) and control (monolingual) groups divided by the pooled standard deviation of the two groups (Cohen's *d*). Hedges (1981) observed that Cohen's '*d*' may yield inflated effect sizes when samples are small. To correct for such bias in effect size, the obtained Cohen's '*d*' values were converted to Hedges's '*g*' using the effect size calculator. Then the effect size obtained as Hedges's '*g*' for each cognitive attribute was calculated by taking the simple average of the sum of the effect sizes from each of the experiments divided by the number of experiments.

## **III. Results**

First of all, several studies on the cognitive consequences of bilingualism were reviewed to identify the cognitive benefits in favor of bilinguals. The identified benefits were attentional control, working memory, metalinguistic awareness, metacognitive skills, symbolic representation and divergent thinking, and problem solving. In the final analysis, 32 studies were included as described in Table 1. The studies were organized in two categories as early graders and later graders depending on the grade level of the sample. Children from kindergarten to grade 6 were identified as early graders and people above grade 10 and particularly having post-secondary qualification were identified as later graders. The effect size with respect to each of the cognitive

benefits for early graders, later graders and also the combined effect size are reported in Table 2. The comparison of effect size between early and later graders is presented in Figure 1 and comparison among the cognitive measures with respect to combined effect size is presented in Figure 2. Cognitive measure-wise discussions are as follows.

**Attentional control:** Bialystok, Craik, Klein and Viswanathan (2004) have conducted five experiments on the Mean Reaction Time (MRT) to respond to incongruent items (Simon effect) of Tamil-English, Mixed-English, and French-English bilinguals with control groups of Tamil, Mixed, and French monolinguals. The studies were carried out on equal number of monolingual and bilingual subjects in each experiment. The sample sizes for the experiments range between 20 and 64 resulting in a total sample size of 154 from each of monolinguals and bilinguals. The participants belonged to different age groups having completed post secondary qualification. The attentional control of monolingual and bilinguals were compared using measures of mean reaction time in processing different language input in their first language. Bilinguals were found to have lower mean reaction time compared to monolinguals in each of the groups. The effect sizes (Hedge's 'g') of the mean differences were computed for each group which ranged between 1.03 and 2.45, resulting in an average effect size of 1.94. This effect size is definitely large enough to conclude that bilinguals have a strong advantage in attentional control over monolinguals during adult years.

Similarly, Bialystok and Martin (2004) conducted four experiments on French-English and Chinese-English bilinguals with control groups of French and Chinese monolinguals. The studies were carried out on a total of 203 children each of bilingual and monolingual groups from kindergarten using measures of reaction time for color, shape, location in computerized tests of attentional control. In each of these studies, bilinguals were found to have performed better than the monolinguals. The Hedge's 'g' was calculated for each of the groups which ranged between 0.35 and 0.83. The average of the effect size for attentional control of the Kindergarten children is found to be 0.56, while the average effect size for the post secondary groups is found to be 1.94. Hence, the findings not only support that bilinguals even at the kindergarten level have better attentional control than their monolingual counterparts, but also point to the fact that the attentional control among bilinguals improves faster than the monolinguals across the age. Further, to subsequently facilitate comparison among different cognitive measures, the grand mean of effect size for all the 9 experiments is calculated as 1.25 (Hedges 'g'). This effect size of 1.25 is in fact very large to indicate that bilinguals have much better attentional control compared to their monolingual counterparts. Hence, it may be concluded that bilingualism promotes attentional control among children which improves with age.

**Working memory:** In the second part of meta-analysis, three studies including two experiments of Bialystok et al., (2006) and one of Bialystok et al., (2012) were synthesized to estimate the bilingual advantage in working memory. The participants of the studies were 216 Mixed-English bilinguals and equal number of monolinguals all of whom have post secondary qualification. A dual task paradigm including both letters and numbers were used as measures of working memory efficiency in each of the three experiments. In all these experiments, bilinguals have shown better working memory efficiency than monolinguals. The effect size for the experiments ranged between 0.48 and 0.91 resulting in an average effect size of 0.73 (Hedge's g). Hence, this effect size is good enough to conclude that bilinguals have better working memory efficiency compared to their unilingual counterparts.

Further, the results of three experiments; Humphreys and Mumtaz (2001), Gutierrez-Clellen et al., (2004), and Aburabia and Siegel (2002) relating to working memory of the children from Grade II to Grade VI were analyzed. The studies respectively used Urdu-English, Spanish-English, and Arabic-English bilinguals and Urdu, Spanish and Arabic monolinguals. The sample sizes for the three studies were respectively 120, 44, and 63 resulting in a total sample of 227 monolingual and bilingual children. The tasks used in the studies were competing language processing tasks and dual processing comprehension tasks. In each of these studies, bilingual children were found to have better working memory efficiency compared to their monolingual counterparts. However, the effect sizes for the studies were not very large only ranging between 0.23 and 0.36 and the average effect size being 0.31 (Hedge's g). Hence, it may be concluded that during childhood years, the working memory efficiency of bilingual children are just little better than their monolingual counterparts. However, for bilingual children, the improvement in working memory efficiency is faster compared to their monolingual counterpart as they grow up in age. The findings stand in support of several other studies which claim bilinguals' superiority in working memory. The combined effect size for all the six experiments is 0.52 (Hedge's g).

**Metalinguistic awareness:** In the third part of the meta-analysis, the studies of Love et al., (2003) and Sanz (2007) were analyzed to estimate the metalinguistic awareness of monolingual and bilingual subjects. The studies respectively included 71 and 193 participants of Mixed-English bilinguals and comparable monolinguals having post secondary qualification. While the experiment of Love et al., (2003) used syntactic processing, Sanz (2007) used several measures of metalinguistic awareness. The effect sizes for the two studies are respectively 1.47 and 0.93, resulting in a combined effect size of 1.20 (Hedge's g). In fact, the effect size is large enough to

point out that bilinguals have better metalinguistic awareness compared to their monolingual counterparts even during adult years.

Similarly, results of experiments conducted by Oller et al., (2007) and Oller et al., (2013) were analyzed to estimate the differences in the metalinguistic awareness of monolingual and bilingual children. The experiment of Oller et al., (2007) included 288 Grade 2 Spanish-English bilingual children and equal number of Spanish monolingual children as control group. On the other hand, the experiment Oller et al., (2013) included 150 Grade 4 Chinese-English bilinguals with a control group of equal number of Chinese monolinguals. In both these experiments, several metalinguistic awareness measures such as passage comprehension, verbal analogy and vocabulary were used. The effect sizes of the study are respectively 1.07 and 0.51 yielding to a combined effect size of 0.79. Hence the results point out that even during early school years, there is a strong difference in the metalinguistic awareness in favor of bilingual children. Further also the change in the effect size from 0.79 to 1.20 is indicative of the fact that bilinguals grow faster in metalinguistic awareness compare to monolinguals. The combined effect size for all the four experiments is 1.00 (Hedge's *g*).

**Metacognitive skills:** In the fourth part of meta-analysis, studies of Ransdell et al., (2006) and Reichard et al., (2004) were analyzed to estimate the metacognitive skills of post secondary monolingual and bilingual subjects. The studies respectively consisted of 137 and 350 Mixed-English bilingual subjects with comparable monolingual control groups. The metacognitive awareness measures included self-rating of reading, writing, speaking and listening skills of the participants. In both these studies, although bilingual superiority in metacognitive skills was observed, the effect sizes were respectively 0.16 and 0.39 resulting in a combined effect size of 0.28. This effect size suggests to a lower level of metacognitive difference among adult unilingual and bilingual subjects.

On the other hand, studies of Lam (2009) and Vendergrift (2002) were analyzed to estimate the metacognitive skills of Grade 6 and Grade 4 children. The studies respectively used 40 Chinese-English and 420 French-English bilinguals with comparable control groups. The effect sizes of these two groups are respectively 0.41 and 0.32 resulting in a combined effect size of 0.37. This is also a low effect size to suggest a lower level of difference in metacognitive skills among monolingual and bilingual subjects. Further also there is no good sign of better development in the metacognitive skills of bilingual subjects. As results of the meta-analysis are not in conformity with findings of many prior studies, more number of relevant studies needs to be examined for further meta-analysis. The combined effect size for for all the four experiment is only 0.33 (Hedge's '*g*').

**Symbolic representation and divergent thinking:** In the fifth part of meta-analysis, results of two studies (Bialystok, 2009; Kharkhurin, 2011) respectively comparing French-English and Farshi-English bilingual and French and Farshi monolingual among post secondary students in symbolic representation and divergent thinking were analyzed. The studies respectively included 64 and 135 participants in each of the bilingual and monolingual groups. In both the studies, bilinguals were found to outperform monolingual counterparts in tests of both symbolic representation and divergent thinking. The effect sizes of the two studies are respectively 1.26 and 0.86, resulting in a combined effect size of 1.06 (Hedge's '*g*'), which is large enough to imply that bilinguals are superior to monolinguals in symbolic representation and divergent thinking during post secondary stage.

Similarly, the results of three experiments of Bialystok's (1997) relating to symbolic representation and divergent thinking of kindergarten children were synthesized. The participants in the studies were French-English and Chinese-English bilinguals and French and Chinese monolinguals of kindergarten classes. The tasks used in the study to measure symbolic representation and divergent thinking were moving word problems and consistent-inconsistent word size problems. In all these studies bilinguals were found better than monolinguals in symbolic representations and divergent thinking. The effect sizes of the studies are respectively 1.04, 1.32, and 0.47. Hence, the combined effect size of the three experiments is 0.94 which implies that even in kindergarten classes, bilinguals demonstrate superiority in measures of symbolic representation and divergent thinking compared to monolinguals. The combined effect size over all the five experiments is 1.00 (Hedge's *g*).

**Problem solving:** In the final part of meta-analysis, studies of Clarkson and Galbraith, (1992) and Demie and Strand (2006) which examined the problem solving behavior of bilingual and monolingual students respectively of grade 6 and grade 10 were analyzed. Clarkson et al. conducted their study on 96 Pidgin-English bilinguals and same number of Pidgin unilinguals using mathematical problems. Demie et al. conducted the study on 1026 Mixed-English bilingual and respective monolingual students of Grade 10 using standardized problem solving test. In both these studies bilinguals were found better in problem solving skills compared to their monolingual counterparts. The effect sizes of the studies are respectively 0.63 and 0.78 resulting in a combined effect size of 0.71. Hence, this effect size is large enough to conclude that bilinguals have better problem solving skills compared to their monolingual counterparts even during later grades in school.

Similarly, two studies of Bialystok and Mazumdar (1998) which compared the problem solving behavior of grade 3 French-English and Bengali-English bilinguals respectively with French and Bengali monolinguals were synthesized. Each of the studies has comparable sample size of 71 from monolingual and

bilingual groups. The tasks used in both the studies were block design and water level tasks which measures the carry over effect of linguistic advantage to non-linguistic tasks. In both these studies, bilinguals outperformed their monolingual counterparts in problem solving. The combined effect size for both the studies were 0.35 to suggest that even though small in effect size, bilingual children are better in problem solving compared to their monolingual counterparts. The mean of the combined effect size of the four studies is 0.53 (Hedge's 'g').

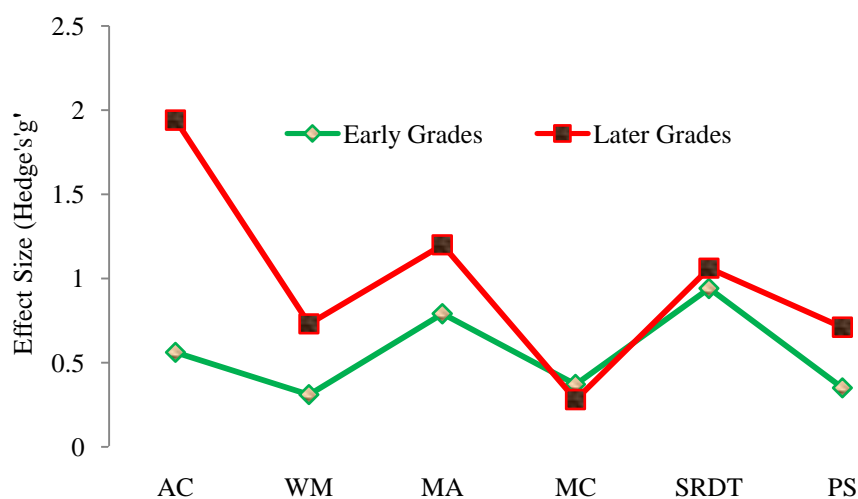
**Table 1.** Summary of the coded studies during the period from 1992 to 2014

Dimension of the cognitive benefit	No. of studies coded	Minimum sample size	Maximum sample size	Total sample size	Grade of participants
Attentional Control	9	20	67	357	Kindergarten to Post Secondary
Working Memory	6	44	120	443	Grade 2 to Post Secondary
Metalinguistic Awareness	4	71	288	702	Grade 2 to Post Secondary
Metacognitive Skills	4	40	420	947	Grade 4 to Post Secondary
Symbolic Rep. & Divergent Think.	5	64	135	448	Kindergarten to Post Secondary
Problem Solving	4	71	1026	1264	Grade 3 to Grade 10
	32	20	1026	4161	

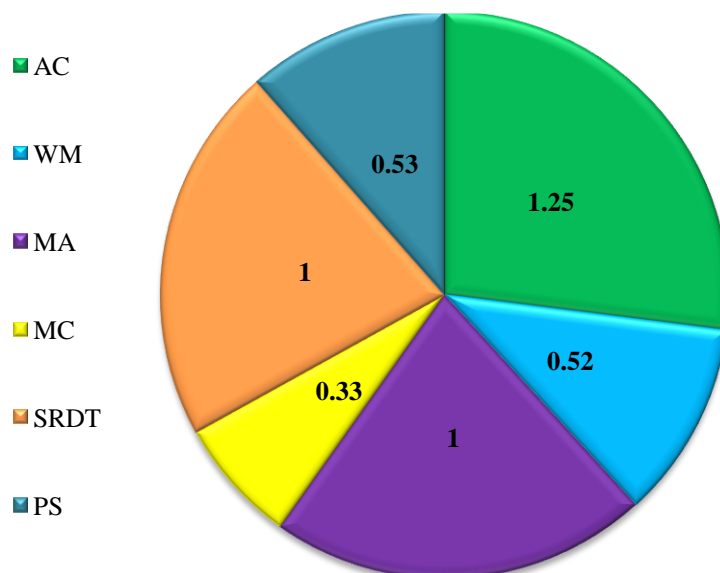
**Table 2.** Average effect size (Hedged 'g') for each of the cognitive measures calculated from the coded studies

Dimension of the cognitive benefit	Attentional Control	Working Memory	Metalinguistic Awareness	Metacognitive Skills	Symbolic Rep. & Divergent Think.	Problem Solving
Average Effect Size for early grades	0.56	0.31	0.79	0.37	0.94	0.35
Average Effect Size for later grades	1.94	0.73	1.20	0.28	1.06	0.71
Combined Effect Size (Hedged 'g')	1.25	0.52	1.00	0.33	1.00	0.53

Note: Effect size interpreter: Small- 0.2\*, Medium- 0.5\*\*, Large-0.8\*\*\*, Very large-1.4\*\*\*\*



**Figure 1.** Effect size comparison of early and later graders



**Figure 2.** Effect size of Hedge's 'g' for cognitive measures

*Note:* In the above figure, AC is attention control, WM is working memory, MA is metalinguistic awareness, MC is metacognitive skills, SRDT is symbolic representation and divergent thinking, and PS is problem solving

#### IV. Conclusion

The Figure 1 above shows that from early to later grades, maximum developments take place among the bilinguals with respect to attentional control which substantially prove the inhibitory control hypothesis of the bilinguals. As the bilinguals experience more and more processing of language inputs in both the languages, they develop better inhibitory mechanisms to control the interference of the language not in operation. As also observed in Figure 1, bilinguals in later grades have substantial developments in working memory efficiency which further supports the claim that bilinguals' efficiency in inhibiting the processing of non-operational language help them not only to overcome cognitive overload but also to be more strategic in information processing. Metalinguistic awareness is also found to have substantially improved from early to later grades, which justify the reason that more exposure to two languages helps the bilinguals to be better apprised of the informal or meta-aspects of the structure, operation and meaning of the language. Similarly, substantial improvement is observed among bilinguals with respect to problem solving skills. It may be pointed out that having exposed to more language inputs from both languages; bilinguals tend to become more language independent and sensitive to non-verbal cues and contents of languages which help them to be better in solving problems of non-verbal tasks. However, metacognitive skills and skill of symbolic representation and divergent are not found to have substantially developed from early to later grades. Because, many studies have claimed bilingual superiority in both these skills, lack of a developmental trend in the present study suggests for further inquiry using more studies from diverse backgrounds of research. This may be considered as the limitation of the present study.

Similarly, the Figure 2 above shows the combined effect sizes for different cognitive outcomes associated with bilingualism. It is observed in the figure that bilingualism produced the largest effect on attentional control with a mean effect size of 1.25. On the other hand, bilingualism produced the second largest effect on both metacognitive awareness, and symbolic representation and divergent thinking having an effect size of 1.00 each. Similarly, working memory and problem solving have effect sizes of respectively 0.52 and 0.53 to show moderate influence of bilingualism on these two cognitive measures. Finally, bilingualism is found to have least influence on metacognitive skills having an effect size of only 0.33. Hence, it may be concluded that although bilingualism benefits the cognitive development, different cognitive abilities are not equally influenced by bilingualism. However, it cannot be ruled out that such effects of bilingualism may also change when the second language is other than the English.

#### Implications of study

India is a land of multi-language, multi-culture and multi-ethnicity where nearly 7% of the Indian population or about 90 million people use English as their second language. These people particularly constitute the students and elite groups who are the foundations of the Indian society. Long since, there have been arguments in favor of mother tongue education at least in schools considering English medium education as burden to children. The findings of present meta-analysis utilizing studies from diverse socio-cultural contexts

would definitely help to change the attitude of some people that learning English as a second language is not a handicap but a benefit.

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