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# Does Age of Second-Language Acquisition Improve Intellectual Processing Abilities?

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# Abstract

Past research on bilingual education indicates that the onset-age of second language learning is negatively associated with both second language proficiency and the cognitive benefits of being bilingual. However, there is inconsistency in the bilingual education field as to whether bilingual speakers benefit from enhanced intellectual processing abilities compared to monolingual speakers. The critical period hypothesis states that during childhood development a certain window of time exists in which second language acquisition skills are strongest. This hypothesis provides the theoretical foundation for my research study. In the current study, I synthesize evidence on the associations between onset-age of second language acquisition and the cognitive outcomes of being bilingual. There are two research objectives; the first is to identify whether bilingual speakers benefit from enhanced intellectual processing abilities compared to monolingual speakers. The second research objective is to identify if early second language acquisition leads to enhanced intellectual processing abilities compared to late second language acquisition. I searched electronic databases in order to identify studies that reported quantitative associations between second language acquisition and intellectual processing abilities. Using my inclusion and exclusion criteria, I identified a total of 18 articles (20 studies) that met the criteria. I conducted a meta-analysis to compare the intellectual processing abilities of monolinguals, early bilinguals, and late bilinguals. No difference was found between the monolinguals and the bilinguals regarding their intellectual processing abilities. No difference was found between early and late bilinguals regarding their intellectual processing abilities. I discuss the implications of the study for the field of bilingual education and second language learning.



*Keywords:* second language learning, age of acquisition, critical period, meta-analysis

# DOES AGE OF SECOND LANGUAGE ACQUISITION IMPROVE INTELLECTUAL PROCESSING ABILITIES?

by

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# Introduction

## Onset-Age of Second-Language Acquisition

Past research in the field of bilingual education indicates that the onset-age of second language learning is negatively associated with second language proficiency (Luk, De Sa, & Bialystok, 2011). Indeed, the conclusion that young children can achieve fluency in a second language more easily than adults is accepted by the majority of psycholinguists. A number of studies conducted on the onset-age of second-language acquisition indicate that it is easier for children to learn a second language than it is for adults (e.g., Ellis, Hafeez, Martin, Chen, Boland, & Sagarra, 2014; Erdocia, Zawaiszewski, & Laka, 2014; Luk et al., 2011; Nicolay & Poncelet, 2013). The notion that the onset-age of second language acquisition is negatively associated with second language proficiency provides the basis for the critical period hypothesis originally proposed by Penfield and Roberts (1959). This hypothesis states that there exists a certain window of time during childhood development in which second language acquisition skills are strongest (Lenneberg, 1967; Penfield & Roberts, 1959).

According to proponents of the critical period hypothesis, once that window of time has ended, second language acquisition becomes much more difficult (Penfield & Roberts, 1959). In fact, proponents of the hypothesis would argue that once that critical time has ended, fluency in the acquired second language will not be possible (Penfield & Roberts, 1959). Thus, the hypothesis is predicated on the assertion that the age of second language acquisition moderates a speaker's command of the acquired second language. According to Penfield and Roberts (1959), this window extended up to the age of nine. However, researchers disagree considerably over how long that window may be if, in fact, it exists at all (e.g., Hakuta, Bialystok, & Wiley, 2003). Some researchers have argued that the window ends by the time a child is 6 years of age (e.g., Pinker, 1994). Other researchers have insisted that this window extends all the way through puberty, until the age of 16 (e.g., Hakuta, Bialystok, & Wiley, 2003). This debate on the time-frame of the critical period hypothesis is further complicated by the fact that the notion of fluency also remains subjective - another subcategory in linguistics in which a consensus has not been achieved (Hakuta, Bialystok, & Wiley, 2003).

The field of bilingual education also includes another prominent theory on second language learning that is called social identity theory. According to social identity theory, language learning is intrinsically related to one's social identity (Tajfel, 1974). This theory is predicated on the assertion that the level of motivation and investment in acquiring the second language moderates the speaker's ability to learn the second language (Gardner & Lambert, 1959). The theory was first developed by Tajfel (1974) who wrote that an individual's identity was acquired from achieving membership in a particular social group. Giles and Johnson (1987) developed this theory further by focusing on language itself as a group membership marker and these researchers also renamed the framework and called it "ethno-linguistic identity theory". Yet, many researchers continue to call the framework "social identity theory".

My study is an attempt to reframe the focus of the second language learning debate on to the cognitive outcomes of second language learning as opposed to the level of second language fluency the speaker has acquired. Of the two theoretical frameworks that are the most prominent in the field of bilingual education - i.e. the critical period hypothesis, and social identity theory- the former provides the theoretical foundation for my research study. I had two research objectives. The first was to identify whether bilingual speakers benefit from enhanced intellectual processing abilities compared to monolingual speakers. The second objective was to identify whether early second-language acquisition would lead to enhanced intellectual processing abilities compared to late second-language acquisition. I hoped my research would improve our knowledge of both second language learning and its cognitive correlates.

## Review of Literature

### Neural Structure of Bilingual Individuals

Past research indicates that there are many potential benefits to being bilingual (Wiseheart, Viswanathan, & Bialystok, 2016; Valerian, 2015). Clarkson (1992) found some indication that bilingual students fluent in both languages performed better than monolingual students on two mathematical tests. However, this did not remain true for students who had failed to achieve fluency in the second language (Clarkson, 1992). Wiseheart and colleagues (2016) demonstrated that bilingual individuals were more skilled in switching between attentional tasks that were stimulus-response based than were monolingual individuals. These researchers concluded that the singular ability to switch between two languages at will, when necessary, may strengthen attentional-control abilities. Wiseheart and colleagues (2016) argue that because bilingual individuals regularly switch between their spoken languages with ease they have developed skills that enhance their task switching and attentional control abilities. According to these researchers, regardless of which language an individual is using to converse at a given moment in time, both languages are active simultaneously in the individual's brain. This conclusion has been supported in other studies as well (e.g., Kroll & Fricke, 2014; Valerian, 2015). Thus, Kroll and Fricke (2014) argue that if an individual who is French-English bilingual is speaking French, the individual's knowledge of the English language is still active in the brain enabling the speaker to move rapidly and easily between the two languages (i.e., French and English).

### Foreign-Language Education Services in the United States

In most U.S. education systems, second language learning services for native English speakers are an optional elective for children 13 years or older. O'Rourke, Zhou, and Rottman, (2016), found that seven out of fifty states (New York, Connecticut, Delaware, Maine, Michigan, New Jersey, and Tennessee) require foreign language study as a general education requirement once a child is 13 years of age. In addition to these seven states, the District of Columbia also requires two years of world language study (O'Rourke, Zhou, & Rottman, 2016). Jauregui (2015) estimates that U.S. students choosing second language education services in public schools will have dedicated an average of 300 hours over the course of two years to learning a second language. However, research indicates that Americans are much less likely to be bilingual than citizens of other economically developed countries (e.g., Duncan, 2010; Jauregui, 2015; Tochon, 2009).

Overall, the U.S. does not produce bilingual speakers at the same rate as other countries (Duncan, 2010; Jauregui, 2015). In the year 2010, the United States Census Bureau created the American Community Survey (ACS) and with this data collection has kept an annual record of the number of bilingual individuals in the country (U.S. Census Bureau, 2013). The ACS makes it evident that second language acquisition in the United States is facilitated primarily by immigration status and the need to assimilate (Jauregui, 2015; U.S. Census Bureau, 2013). Bilingual speakers in the U.S. are most frequently first-generation residents who acquire English as a second-language (U.S. Census Bureau, 2013). The fact that the onset-age of second language learning in the U.S. is 13 is one possible explanation for why the U.S. education system is not producing more bilingual speakers.

**Limitations in the Research Field**

A significant complication that exists in the field of bilingual education is the lack of consensus regarding general terminology. Published articles in the field rarely implement clear and concise definitions (Grant & Dennis, 2017; Kaushanskaya & Prior, 2015; Kroll & Fricke, 2014; Pons, Bosch, & Lewkowicz, 2015; Valerian, 2015). For example, Grant and Dennis (2017) use the term “executive functions” to refer to what Kaushanskaya and Prior (2015) label as “cognitive mechanisms”. Vague overlapping terminology occurs frequently in the published literature focused on bilingual education. Unclear conceptualization among researchers may be problematic because there are numerous mechanisms that could be included under an umbrella term like “executive functions” (Grant & Dennis, 2017; Kaushanskaya & Prior, 2015; Valerian, 2015). Similarly, “cognitive mechanisms” is also a generalized label that refers to a variety of neural and cognitive functions (Grant & Dennis, 2017; Valerian, 2015). Thus, it is necessary for researchers to conceptualize and clarify the constructs they are writing about for the benefit of the reader (Grant & Dennis, 2017; Kaushanskaya & Prior, 2015; Kroll & Fricke, 2014; Valerian, 2015).

Another major complication in the field of bilingual research is that no two bilingual speakers are exactly alike (Byers-Heinlein, 2014; Valerian 2015). Researchers have found controlling for existing differences in bilingual participants to be challenging because bilingual speakers are not a homogenous group (Byers-Heinlein, 2014; Valerian 2015). Indeed, becoming bilingual is not a random occurrence. People may choose to adopt another language or parents may choose to teach their children more than one language (Byers-Heinlein, 2014). However, each bilingual individual may have a unique and varied life experience. Thus, differences in cognitive function may not be due to bilingualism but instead may be due to other factors that researchers have not yet taken into consideration (Struys et al. 2015; Valerian 2015).

## Conceptualization of Key Terms

In this paper, both the terms “cognitive functions” and “intellectual processing abilities” refers to mental processes involved in how humans develop knowledge. That is to say, how we direct our attention, perceive, remember, think, and solve problems (Pliatsikas & Luk, 2016; Pons, Bosch, & Lewkowicz, 2015). The category of “executive functions” is a subcategory of cognitive processes (Pliatsikas & Luk, 2016; Pons, Bosch, & Lewkowicz, 2015). Executive functions to refer to higher-order, complex cognitive processes, such as thinking, planning, and problem solving (Pliatsikas & Luk, 2016; Pons, Bosch, & Lewkowicz, 2015). Executive functions are more complex then basic cognitive functions because they often involve the ability to coordinate different basic cognitive processes such as selective attention or our capacity to focus on specific things while ignoring others (Pliatsikas & Luk, 2016; Pons, Bosch, & Lewkowicz, 2015). All such functions are specifically linked to the brain’s prefrontal cortex (Pons, Bosch, & Lewkowicz, 2015).

## Research Questions

The following research questions were the impetus of my literature review and research investigation: Do bilingual speakers benefit from enhanced intellectual processing abilities compared to their monolingual counterparts? Does early second language acquisition benefit children’s intellectual processing abilities more than late second language acquisition?

## Hypotheses and Objectives

I have two hypotheses. First, I hypothesize that bilingual speakers will show enhanced intellectual processing abilities when compared to monolingual speakers. Second, I hypothesize that early bilinguals will show enhanced intellectual processing abilities when compared to late bilinguals. I am comparing monolingual and bilingual language learners who were observed in prior research. The outcome variable will be the level of cognitive enhancement (or intellectual processing abilities) observed by the researchers.

## Methods

### Procedure

I chose to conduct a meta-analysis because I wanted to synthesize research findings in the field of bilingual education. I found there to be a great deal of inconsistency in the field and studies with statistical significance can only examine whether findings are likely to be due to chance. However, effect sizes provide a way to quantify the difference between two groups by emphasizing the size of the difference rather than jumbling this with sample size (a common problem with tests of statistical significance). Effect sizes also help future researchers better understand the magnitude of the differences found in past research. Therefore, I chose to conduct a meta-analysis because I wanted to develop a single conclusion with greater statistical power in order to further the field of bilingual education.

### Step 1. Retrieving Sources

I searched electronic databases such as PsycINFO and PsycArticles to identify studies that reported quantitative associations between second language acquisition and enhanced intellectual processing abilities. I compiled different sources to familiarize myself with the field of bilingual education. I also assessed the field of research by investigating inconsistencies and gaps in the published literature.

### Step 2. Establishing Inclusion and Exclusion Criteria

Due to the fact that my hypotheses were focused on comparing the intellectual processing abilities of monolinguals and bilinguals (both early and late), not all of the articles that were compiled from the databases were relevant to my study. I established article inclusion criteria to better conduct my analysis. I decided on the specific characteristics that the research articles needed to share in order to be included in my study. My inclusion criteria are listed in Table 1.

Table 1. *Article Inclusion Criteria*

| Inclusion Criteria | Description of Criteria |
|---|---|
| Relevance to Topic | Articles must be directly related to the topic for the research analysis but for the review of literature tangentially related articles were still valuable |
| Peer-Reviewed | Articles must be peer-reviewed |
| Age of Material | Publication date was not an excluding factor |
| Design of Studies | Qualitative and quantitative studies can be included for both the research analysis and review of literature |

I also established article exclusion criteria. I found numerous studies that qualified based on my inclusion criteria alone and I was able to use my exclusion criteria to narrow down my list of compiled sources to 18 different research articles. Table 2 lists my exclusion criteria.

Table 2. *Article Exclusion Criteria*

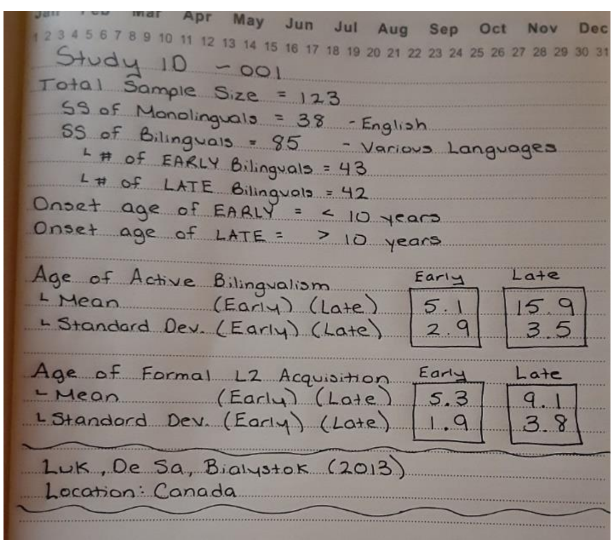
| Exclusion Criteria | Description of Criteria |
|---|---|
| Design of Studies | Research articles that do not include a comparison between the following groups: monolingual speakers and bilingual speakers.<br><br>Research articles that do not specify the age or age-range of second language acquisition.<br><br>Research articles that do not study or focus upon the cognitive outcomes or intellectual processing abilities of second language acquisition or second language learning.<br><br>Research articles that are not English-based publication mediums. |

**Step 3. Data Coding**

**Handwritten Codebook**

I was able to find 18 research articles that achieved all of my criteria. All 18 of these articles were coded into a handwritten codebook. See Figure 1.

Figure 1. *Handwritten Code-Sheet for Study 001 (Luk, Da Sa, and Bialystok, 2013)*



In this codebook I wrote down specific study characteristics there were relevant to my study. These characteristics included information regarding the total sample size of each study, the total sample size of monolinguals in each study, as well as the total sample size of bilinguals (both early and late) in each study. In my codebook I also recorded the country in which the study was conducted. See Table 3.

Table 3. *Study Characteristics for all 18 Research Articles*

| Study # | Research Articles | # Effect Sizes | Sample Size | Countries |
|---|---|---|---|---|
| 1 | LUK, DE SA, BIALYSTOK (2013) | 6 | 123 | Canada |
| 2 | BIALYSTOK, PEETS, MORENO (2014) | 16 | 124 | Canada |
| 3 | WINSLER ET AL (1999) | 3 | 46 | U.S. |
| 4 | NICOLAY & PONCELET (2013) | 8 | 106 | France |
| 5 | YANG & YANG (2016) | 12 | 102 | U.S. |
| 6 | SECER (2016) | 3 | 162 | Northern Cyprus |
| 7 | JASINSKA & PETITTO (2013) | 6 | 59 | Canada |
| 8 | SERRATRICE & DE CAT (2019) | 3 | 172 | U.K. |
| 9 | PATRA, BOSE, & MARINIS (2019) | 14 | 50 | U.K. |
| 10 | WALDRON (2010) | 4 | 36 | U.S. |
| 11 | TAO ET AL (2011) | 10 | 100 | U.K. |
| 12 | UNSWORTH (2013) | 3 | 176 | Netherlands |
| 13 | HIRSH ET AL (2003) | 1 | 63 | Spain |
| 14 | VAID (1987) | 8 | 48 | Canada |
| 15 | KALIA, WILBOURN & GHIO (2014) | 8 | 105 | U.S. |
| 16 | PELHAM & ABRAMS (2014) | 4 | 90 | U.S. |
| 17 | FOUCART ET AL (2014) | 2 | 54 | Spain |
| 18, 19, 20 | BIALYSTOK & MARTIN (2004) | 13 | 67, 30, 53 | China, France, China |

In addition to all of the information listed in Table 3, I recorded the age of acquisition for every bilingual participant in each research study.

### IBM SPSS Software

Once the handwritten codebook was completed, I coded and entered all 18 of these articles into the IBM SPSS Statistics for Windows, version 26 (Oct. 2019). From these 18 articles, I synthesized evidence from 20 different studies on the associations between onset-age of second language acquisition and intellectual processing outcomes. I entered all of the data that was included in my handwritten codebook, as well as additional data from the 18 articles. This additional data included the types of intellectual processing tests included in the different studies as well as the specific cognitive outcomes that were being assessed by each test. See Figure 2.

Figure 2. *Electronic Codebook and Data Entry*

| SUID | DIRECTION | RVALUE | D | ZSCORE | FISHERSZF | LOWERCO | UPPERCOI | VARIANCE | STDEV | STDERROF | TSSIZE | GENDER | COUNTRY | TOTALMO | TOTALBILI | TOTALEAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 001A | 2 | 0.04 | -0.087300 | -0.043600 | 0.040000 | -0.18 | 0.26 | 0.01 | 0.11 | 0.01 | 81.00 | 3 | 2 | 38.00 | 43.00 | 43.00 |
| 001B | 2 | 0.42 | -0.926300 | -0.448100 | 0.447700 | 0.22 | 0.67 | 0.01 | 0.11 | 0.01 | 80.00 | 3 | 2 | 38.00 | 42.00 | 0.00 |
| 001C | 1 | 0.07 | 0.135400 | 0.067600 | 0.070100 | -0.15 | 0.29 | 0.01 | 0.11 | 0.01 | 81.00 | 3 | 2 | 38.00 | 43.00 | 43.00 |
| 001D | 1 | 0.04 | 0.081200 | 0.040600 | 0.040000 | -0.18 | 0.26 | 0.01 | 0.11 | 0.01 | 80.00 | 3 | 2 | 38.00 | 42.00 | 0.00 |
| 001E | 2 | 0.05 | -0.095900 | -0.047900 | 0.050000 | -0.17 | 0.27 | 0.01 | 0.11 | 0.01 | 81.00 | 3 | 2 | 38.00 | 43.00 | 43.00 |
| 001F | 1 | 0.03 | 0.057800 | 0.028900 | 0.030000 | -0.19 | 0.25 | 0.01 | 0.11 | 0.01 | 80.00 | 3 | 2 | 38.00 | 42.00 | 0.00 |
| 002A | 1 | 0.19 | 0.392600 | 0.195000 | 0.192300 | -0.06 | 0.45 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 34.00 |
| 002B | 2 | 0.03 | 0.066000 | 0.033000 | 0.030000 | -0.23 | 0.29 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 34.00 |
| 002C | 1 | 0.07 | 0.141000 | 0.070400 | 0.070100 | -0.19 | 0.33 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 34.00 |
| 002D | 2 | 0.04 | -0.073700 | -0.036800 | 0.040000 | -0.22 | 0.30 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 34.00 |
| 002E | 1 | 0.08 | 0.158600 | 0.079300 | 0.080200 | -0.18 | 0.34 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 34.00 |
| 002F | 2 | 0.05 | -0.104600 | -0.052200 | 0.050000 | -0.21 | 0.31 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 34.00 |
| 002G | 1 | 0.22 | 0.449600 | 0.222900 | 0.223700 | -0.03 | 0.48 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 34.00 |
| 002H | 2 | 0.30 | -0.625000 | -0.307700 | 0.309500 | 0.05 | 0.56 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 34.00 |
| 002I | 1 | 0.14 | 0.291000 | 0.145000 | 0.140900 | -0.11 | 0.40 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 0.00 |
| 002J | 1 | 0.25 | 0.526500 | 0.260300 | 0.255400 | 0.00 | 0.51 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 0.00 |
| 002K | 1 | 0.46 | 1.041000 | 0.499500 | 0.497300 | 0.24 | 0.75 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 0.00 |
| 002L | 1 | 0.21 | 0.436100 | 0.216300 | 0.213200 | -0.04 | 0.47 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 0.00 |
| 002M | 1 | 0.22 | 0.454200 | 0.225200 | 0.223700 | -0.03 | 0.48 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 0.00 |
| 002N | 1 | 0.36 | 0.780600 | 0.381000 | 0.376900 | 0.12 | 0.63 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 0.00 |
| 002O | 1 | 0.04 | 0.085900 | 0.042900 | 0.040000 | -0.22 | 0.30 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 0.00 |
| 002P | 1 | 0.10 | 0.192400 | 0.096100 | 0.100300 | -0.15 | 0.36 | 0.02 | 0.13 | 0.02 | 62.00 | 3 | 2 | 28.00 | 34.00 | 0.00 |
| 003A | 1 | 0.28 | 0.573300 | 0.282900 | 0.287700 | -0.01 | 0.59 | 0.02 | 0.15 | 0.02 | 46.00 | 3 | 3 | 20.00 | 26.00 | 26.00 |
| 003B | 1 | 0.34 | -0.729800 | -0.357300 | 0.354100 | 0.06 | 0.65 | 0.02 | 0.15 | 0.02 | 46.00 | 3 | 3 | 20.00 | 26.00 | 26.00 |
| 003C | 1 | 0.43 | 0.964000 | 0.465100 | 0.459900 | 0.16 | 0.76 | 0.02 | 0.15 | 0.02 | 46.00 | 3 | 3 | 20.00 | 26.00 | 26.00 |
| 004A | 1 | 0.19 | 0.387900 | 0.192800 | 0.192300 | 0.00 | 0.39 | 0.01 | 0.10 | 0.01 | 106.00 | 3 | 4 | 53.00 | 53.00 | 0.00 |
| 004B | 2 | 0.06 | -0.115200 | -0.057600 | 0.060100 | -0.13 | 0.25 | 0.01 | 0.10 | 0.01 | 106.00 | 3 | 4 | 53.00 | 53.00 | 0.00 |
| 004C | 1 | 0.30 | -0.618200 | -0.304400 | 0.309500 | 0.12 | 0.50 | 0.01 | 0.10 | 0.01 | 106.00 | 3 | 4 | 53.00 | 53.00 | 0.00 |
| 004D | 1 | 0.23 | -0.470300 | -0.233000 | 0.234200 | 0.04 | 0.43 | 0.01 | 0.10 | 0.01 | 106.00 | 3 | 4 | 53.00 | 53.00 | 0.00 |
| 004E | 1 | 0.25 | -0.515500 | -0.255000 | 0.255400 | 0.06 | 0.45 | 0.01 | 0.10 | 0.01 | 106.00 | 3 | 4 | 53.00 | 53.00 | 0.00 |

I also analyzed the differences between the intellectual processing abilities of children who acquired a second language at an early time period and children who acquired a second language at a later time period. I included as many demographic characteristics for each article's participant pool as I could. This remained true even if demographic information was not consistent amongst all 18 research articles (i.e. only a few articles recorded the level of parental education for each participant and I entered this data into SPSS anyway).

**Using Cohen's D and not Hedge's G**

An effect size informs researchers about how much one group differs from another on a given outcome measure. There are typically two different measures of effect sizes utilized in meta-analyses; Cohen's d or Hedge's g. Both statistical measures indicate the standardized difference between two means. In fact, these two statistics are very similar except when sample sizes are below 20, in which case, researchers tend to favor Hedges' g over Cohen's d. However, of the 18 articles I had compiled, none of them had a sample size below 20. Moreover, of the two statistics, Cohen's d is the most widely used in research. Therefore, I found it more appropriate to use Cohen's d for my study.

**Retrieving Data from Online Statistical Calculators**

I used three different online websites to retrieve the variances, effect sizes, and confidence intervals for my 20 different studies. The three different websites were: CampbellCollaboration.Org, LyonsMorris.com. and GetCalc.com. Each of these three websites provided me with free statistical calculators that helped me gather data for my research study. Each of these three websites were very user friendly and by entering specific data into the calculator, I was able to gather additional data that I then included in my SPSS codebook. These three online calculators were extremely helpful tools for my data collection process. See Table 4.

Table 4. *Online Statistical Calculators Used for Data Retrieval*

| Website | Calculator Name | Data Entered | Data Retrieved |
|---|---|---|---|
| Campbell Collaboration.org | Practical Meta-Analysis Effect Size Calculator | Pearson's r<br><br>Sample Size | Variances<br><br>95% Confidence Intervals<br><br>Z Scores |
| LyonsMorris.com | The Meta-Analysis Calculator – Data Entry | Means<br><br>Standard Deviations | Cohen's D |
| GetCalc.com | Statistics Standard Error Calculator | Sample Size | Population Standard Deviation |

For research article 14 (Vaid, 1987), the means and standard deviations were not provided in the document itself. Therefore, I used the percentages located in the figures (both figure 1 and figure 2) in the research article as well as the 2x2 Contingency Frequency Table on LyonsMorris.com to calculate the effect sizes from this study (Vaid, 1987). Indeed, this article was the only exception to the data retrieval rules listed in Table 4. For every other article I had compiled, I found the effect sizes (i.e. Cohen's d) by entering the means and standard deviations for each intellectual processing measure into LyonsMorris.com.

**Step 4. Synthesizing the Data using JASP.**

I conducted my meta-analysis using Jeffreys's Amazing Statistics Program (JASP), version 13.1 (2020). JASP is a free computer program for statistical analysis. This program includes an extremely helpful graphical user interface and is very user-friendly.

### Description of the Studies

The 18 articles compiled for this meta-analysis allowed for the computation of 124 effect sizes. One article was a published dissertation. One article consisted of 3 different population samples; 17 articles provided multiple outcome measures as they assessed their participant pool with various measures of intellectual processing abilities. From these 18 articles in total, 11 of them included additional groups as they compared early bilinguals to their age-appropriate monolingual counterparts as well as late bilinguals to their age-appropriate monolingual counterparts. Such articles provided valuable data to synthesize into effect sizes. The total number of participants included in the analyses was 1,723. See Table 5.

Table 5. *Effect Sizes and Correlations for All 18 Research Articles*

| Research Article | Outcome | Cohen's d | Pearson's r |
|---|---|---|---|
| LUK, DE SA, BIALYSTOK (2013) | 1 | -.0873 | .04 |
| | 2 | -.9263 | .42 |
| | 3 | .1354 | .07 |
| | 4 | .0812 | .04 |
| | 5 | -.0959 | .05 |
| | 6 | .0578 | .03 |
| BIALYSTOK, PEETS, MORENO (2014) | 1 | .3926 | .19 |
| | 2 | .0660 | .03 |
| | 3 | .1410 | .07 |
| | 4 | -.0737 | .04 |
| | 5 | .1586 | .08 |
| | 6 | -.1046 | .05 |
| | 7 | .4496 | .22 |
| | 8 | -.6250 | .30 |
| | 9 | .2910 | .14 |
| | 10 | .5265 | .25 |
| | 11 | 1.0410 | .46 |
| | 12 | .4361 | .21 |
| | 13 | .4542 | .22 |
| | 14 | .7806 | .36 |
| | 15 | .0859 | .04 |
| | 16 | .1924 | .10 |
| WINSLER ET AL (1999) | 1 | .5733 | .28 |
| | 2 | -.7298 | .34 |
| | 3 | .9640 | .43 |

| Research Article | Outcome | Cohen’s d | Pearson’s r |
|---|---|---|---|
| NICOLAY & PONCELET (2013) | 1 | .3879 | .19 |
| | 2 | -.1152 | .06 |
| | 3 | -.6182 | .30 |
| | 4 | -.4703 | .23 |
| | 5 | -.5155 | .25 |
| | 6 | -.2603 | .13 |
| | 7 | -.2943 | .15 |
| | 8 | -.2170 | .11 |
| YANG & YANG (2016) | 1 | -1.9491 | .70 |
| | 2 | .0134 | .01 |
| | 3 | .0000 | .00 |
| | 4 | -.2189 | .11 |
| | 5 | 1.0326 | .46 |
| | 6 | 1.3214 | .55 |
| | 7 | -1.2607 | .53 |
| | 8 | .4594 | .22 |
| | 9 | -.9377 | .42 |
| | 10 | -1.2562 | .53 |
| | 11 | .0000 | .00 |
| | 12 | .0000 | .00 |
| SECER (2016) | 1 | -.2756 | .14 |
| | 2 | -.6019 | .29 |
| | 3 | -.1307 | .07 |
| JASINSKA & PETITTO (2013) | 1 | 1.7031 | .65 |
| | 2 | 2.8644 | .82 |
| | 3 | 2.9572 | .83 |
| | 4 | 1.2612 | .53 |
| | 5 | .9194 | .42 |
| | 6 | .4104 | .20 |
| SERRATRICE & DE CAT (2019) | 1 | -.7488 | .35 |
| | 2 | -.1849 | .09 |
| | 3 | -.4559 | .22 |
| PATRA, BOSE, & MARINIS (2019) | 1 | .1071 | .05 |
| | 2 | -.2941 | -.15 |
| | 3 | -.4254 | -.21 |
| | 4 | -.1534 | -.08 |
| | 5 | -.2209 | -.11 |
| | 6 | .0000 | .00 |
| | 7 | -.5230 | -.25 |
| | 8 | -.8366 | .39 |
| | 9 | .5999 | .29 |
| | 10 | -.0730 | -.04 |
| | 11 | -.5256 | -.25 |
| | 12 | -1.1314 | -.49 |

| Research Article | Outcome | Cohen's d | Pearson's r |
|---|---|---|---|
| | 13 | -.5142 | -.25 |
| | 14 | .5714 | .27 |
| WALDRON (2010) | 1 | -2.5154 | .78 |
| | 2 | .3918 | .19 |
| | 3 | -1.5321 | .61 |
| | 4 | -.7293 | .34 |
| TAO ET AL (2011) | 1 | .8262 | .38 |
| | 2 | .4333 | .21 |
| | 3 | -.8801 | .40 |
| | 4 | -.1448 | .07 |
| | 5 | -.7991 | .37 |
| | 6 | -.2861 | .14 |
| | 7 | -.9900 | .44 |
| | 8 | -.2032 | .10 |
| | 9 | -.8286 | .38 |
| | 10 | -.4899 | .24 |
| UNSWORTH (2013) | 1 | .0824 | .04 |
| | 2 | -1.1110 | .49 |
| | 3 | -1.0045 | .45 |
| HIRSH ET AL (2003) | 1 | -2.0403 | .71 |
| VAID (1987) | 1 | -.1202 | -.06 |
| | 2 | -.2010 | -.10 |
| | 3 | -.2010 | -.10 |
| | 4 | -.3242 | -.16 |
| | 5 | -.3871 | -.19 |
| | 6 | -.1403 | -.07 |
| | 7 | -.2622 | -.13 |
| | 8 | .4082 | .20 |
| KALIA, WILBOURN & GHIO (2014) | 1 | -.0171 | .01 |
| | 2 | -.2905 | .14 |
| | 3 | .1888 | .09 |
| | 4 | .0000 | .00 |
| | 5 | -.0856 | .04 |
| | 6 | .0771 | .04 |
| | 7 | -.1073 | .05 |
| | 8 | -.7118 | .34 |
| PELHAM & ABRAMS (2014) | 1 | -.0488 | .02 |
| | 2 | .0500 | .03 |
| | 3 | -.0442 | .02 |
| | 4 | .3330 | .16 |
| FOUCART ET AL (2014) | 1 | -.0008 | .00 |
| | 2 | -.0008 | .00 |
| BIALYSTOK & MARTIN (2004) | 1 | -1.8378 | .68 |

| Research Article | Outcome | Cohen’s d | Pearson’s r |
|---|---|---|---|
| **Study 1** | 2 | -.0006 | .00 |
| | 3 | -.0006 | .00 |
| | 4 | .3165 | .16 |
| | 5 | .3165 | .16 |
| | 6 | -.0006 | .00 |
| BIALYSTOK & MARTIN (2004) **Study 2** | 1 | .7262 | .34 |
| | 2 | .9526 | .43 |
| | 3 | -.0008 | .00 |
| | 4 | -1.0981 | .48 |
| BIALYSTOK & MARTIN (2004) **Study 3** | 1 | -1.8121 | .67 |
| | 2 | .5637 | .27 |
| | 3 | 1.0493 | .46 |

**Age of Acquisition: Early Bilinguals vs. Late Bilinguals**

Regarding the early bilingual group, the mean age for second language acquisition was 4 years. The oldest age at which children in this group began acquiring a second language was 7.7 years, and this was usually in form of a second language immersion program at school. Additionally, a number of children in this group classified as simultaneous bilinguals, which is to say that their age of exposure to a second language was at the same time as their age of exposure to their first language, i.e. infancy (or 0 years).

Regarding the late bilingual group, the mean age for second language acquisition was 9.4 years. The oldest children in this group were 15.9 years of age at the time of their exposure to a second language. To be clear, this was usually in the form of immigrating to a new country and becoming exposed to the second language while enrolled into the school system there.

**Demographics: Countries**

Across the 18 articles included in my analysis, there were 20 different studies. The additional studies resulted from the fact that one article included 3 different studies in 3 different countries (the U.S., France, and China). In total, the 18 articles spanned 9 different countries. For the purposes of synthesizing this data in a parsimonious manner, I categorized these 9 countries into 3 different groups: North American countries (e.g. the U.S. and Canada), European countries (e.g., France, Netherlands, UK, and Spain) and Other (China and Turkey). The largest number of studies (5) were conducted in the U.S. There were 4 studies conducted in Canada, 3 studies conducted in the UK, 2 in Spain, 2 in the Netherlands, and 1 each study conducted in Mexico, France, Turkey, and China respectively. However, one study included participants spread out across 3 different countries (the U.S., Mexico, and China).

**Demographics: Languages**

The majority of the monolingual group (e.g. 80.6%) were English speakers. 9.7% were Francophone monolinguals. 4.8% were Spanish speakers. Turkish and Dutch- speaking monolinguals each made up 2.4% of the monolingual group, respectively. Table 6 lists frequency information regarding the first and second languages of the bilingual participants in my analysis.

Table 6. *The First Language (L1) and Second Language (L2) of the Bilingual Participants*

| L1 | % | L2 | % |
|---|---|---|---|
| English | 43.5 | English | 55 |
| French | 9.7 | French | 19.4 |
| Spanish | 6.5 | Spanish | 3.2 |
| Korean | 9.7 | Dutch | 2.4 |
| Turkish | 2.4 | Various/Other | 20 |
| Bengali | 11.3 | | |
| Cantonese/Mandarin | 15.3 | | |

| L1 | % | L2 | % |
|---|---|---|---|
| Various/Other | 1.6 | | |

**Measurements of Intellectual Processing Abilities**

Of the 18 articles and 20 different studies, there were a variety of intellectual abilities that researchers identified, measured, and analyzed. These abilities included but were not limited to executive functioning abilities, selective attention abilities, nonverbal intelligence, verbal fluency, second language proficiency, inhibitory control abilities, mental flexibility, and verbal working memory. For purposes of my analysis, I created three categories of intellectual outcomes to synthesize the data.

These three categories were stimuli response tests, language fluency/sentence construction tests, and abstract reasoning/nonverbal intelligence tests. To be clear, stimuli response tests capture automatic reactions to stimuli (e.g. a picture, sentence, or symbol) by timing each participant's rate of response to said stimuli. These types of measures are sometimes called response inhibition tests. I grouped every measured outcome from these 18 articles into one of these three outcome categories. Table 7 lists the three intellectual processing categories and the variables that were included in each category.

Table 7. *The 3 Different Categories for Intellectual Processing Tests*

| Outcome Category | Intellectual Processing Tests |
|---|---|
| Stimuli Response Tests | |

| | |
|---|---|
| | Flanker Task, KiTAP Test of Attentional Performance in Children, Attention Network Test for Children (ANT-C), Attention Network Test for Adults (ANT-A), Simon Task, Trail-Making Tests (TMT-A and TMT-B), Functional Near-Infrared Spectroscopy Test, Stroop Task, Colour Shape Switch Task, Auditorily Cued Number-Numeral Task. |
| Language Fluency / Sentence Construction | English PPVT III, Wug Test, Sentence Judgement Tasks, Verbal Fluency Tasks, Word Processing Tests, French PPVT III (EVIP), DELV Articles, Oxford Quick Placement Test, Boston Naming Test, Verb Generation Correction Test, Dutch PPVT III, Name Agreement tasks, Expressive Vocabulary Test, Comprehensive Test of Phonological Processing, and generic language proficiency tests. |
| Abstract Reasoning/ Nonverbal Intelligence | Raven Matrices Nonverbal Intelligence Test, Backwards Digital Recall Task, Forward Digital Recall Task. |

The most common measure used across all 20 studies, was the Flanker Task (a stimuli response test) used 18 different times throughout the articles. The most common language proficiency measure was the English PPVT III test, which was used 12 different times throughout the articles. The most common abstract reasoning measure was the Raven Matrices Nonverbal Intelligence Test which was used 7 different times throughout the articles.

## Results

I conducted a meta-analysis using a random effects statistical model. I chose to employ a random effects model after first conducting a fixed effects model and finding that the test of residual heterogeneity showed variation among the studies (i.e. I found that not all of the studies were evaluating the same effect). When calculating a confidence interval for a fixed effects model, there is an assumption made that the observed differences among the studies included in the analysis are due to chance and that there is no statistical heterogeneity. When calculating a confidence interval for a random effects model, there is an assumption made that the effects being estimated among the different studies are not identical, but instead follow a distribution. To be clear, the center of this data distribution describes the average of the effect sizes, while its width describes the degree of heterogeneity. For my analysis, I found a significant number of effect sizes falling within the cone. The residual heterogeneity estimates showed that there was a moderate level of heterogeneity in my sample ($\tau^2 = 0.626$, CI: 0.495 - 0.818). It is for this reason that I decided a fixed effects model would be inappropriate. Therefore, I chose to employ a random effects model to compare the intellectual processing abilities of monolinguals, early bilinguals, and late bilinguals.

My first hypothesis was that both early bilinguals as well as late bilinguals would show enhanced intellectual processing capabilities when compared to the monolinguals. The resulting analyses are presented in Table 8 and Table 9. As can be seen in Tables 8 and 9, the Omnibus coefficient is not significant ($p = .214$). The effect size is not significant, and the confidence interval straddles zero.

Table 8. *Hypothesis 1. Random Effects Model*

| | Q | df | p |
|---|---|---|---|
| Omnibus test of Model Coefficients | 1.546 | 1 | 0.214 |
| Test of Residual Heterogeneity | 186745.807 | 123 | < .001 |

This hypothesis was not supported by the results of my analysis. Thus, there is no difference between the monolinguals and the bilinguals regarding their intellectual processing abilities.

Table 9. *Hypothesis 1. Coefficients*

| | | | | | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | Estimate | Standard Error | z | p | Lower | Upper |
| Intercept | -0.088 | 0.071 | -1.244 | 0.214 | -0.228 | 0.051 |

*Note*. Wald test.

My analysis indicated that there was no difference between the monolinguals and the bilinguals regarding their intellectual processing abilities. Thus, my hypothesis that monolinguals and bilinguals would differ in their intellectual processing abilities was not supported by the results of my analysis.

A rank correlation test for Funnel plot asymmetry indicated that the resulting Kendall's $\tau$ was equal to .08 and not significant ($p = .181$). This finding suggested that there was no publication bias in my synthesis. In addition to the results from the Funnel Plot analysis, examination of the fail-safe N indicated that a minimum number of 482,418 additional studies would be needed to change the conclusions of my meta-analysis.

Due to the fact that this is such a large number of additional studies, I was confident that the conclusions of this meta-analysis were not subject to publication bias.

My second hypothesis was that early bilinguals would show enhanced intellectual processing abilities when compared to the late bilinguals. As can be seen in Tables 10 and 11, the Omnibus coefficient is not significant (p = .232). The effect size is not significant, and the confidence interval straddles zero.

Table 10. *Hypothesis 2. Random Effects Model*

| | Q | df | p |
|---|---|---|---|
| Omnibus test of Model Coefficients | 2.923 | 2 | 0.232 |
| Test of Residual Heterogeneity | 178673.680 | 121 | < .001 |

*Note.* *p* -values are approximate.

Thus, there is no difference between the early and late bilinguals regarding their intellectual processing capabilities. The results of my analysis show that the age at which a child learns their second language does not matter.

Table 11. *Hypothesis 2. Coefficients*

| | | | | | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | Estimate | Standard Error | z | p | Lower | Upper |
| intercept | 0.156 | 0.235 | 0.663 | 0.507 | -0.304 | 0.616 |
| CATEGORY | -0.009 | 0.214 | -0.044 | 0.965 | -0.428 | 0.409 |
| OVERALLAGE | -0.033 | 0.030 | -1.106 | 0.269 | -0.092 | 0.026 |

*Note.* Wald test.

The results of my analysis show that the age at which a child learns their second language did not influence the intellectual processing abilities. That is, it is clear that there was no difference between the early and late bilinguals regarding their intellectual processing abilities. Thus, my hypothesis was not supported by the results of my analysis. I had categorized the intellectual processing abilities utilized in the 18 articles (20 studies) included in my analysis into 3 categories (stimulus response tests, language proficiency/verbal reasoning tests, and abstract reasoning/nonverbal intelligence tests. The results of the Wald test indicated that only the language outcome was significant, Coefficient: -0.27; Standard Error .098; $p < .05$.

However, the direction of the outcome was unexpected. According to the results of this comparison, the monolingual groups performed better on the language proficiency/verbal reasoning tests than did either of the bilingual groups (i.e., the early vs. late achievers of bilingualism). According to my analysis, the difference between monolinguals and bilinguals (either early or late) is stronger for European countries than for North American countries. The mean effect size for European countries was -.308. The mean effect size for North American countries was .046. The mean effect size for Other Countries was .101. This pattern of effect sizes indicated that the outcome numbers for intellectual skills were better for European monolinguals than for European bilinguals. Thus, it appears that in North American countries the difference between monolinguals' and bilinguals' intellectual processing capabilities is zero. However, in European countries monolinguals appear to perform better than their bilingual counterparts on such tests. In other countries (e.g., Turkey, and China) it is probable that bilinguals may perform better than their monolingual counterparts.

## Discussion

My first hypothesis was that both early bilinguals as well as late bilinguals would show enhanced intellectual processing abilities when compared to the monolinguals. This hypothesis was not supported by the results of my analysis. I found no evidence of overall difference between the monolinguals and the bilinguals regarding their intellectual processing abilities. This remained true regardless of the first or second language spoken by the participant. In fact, according to the results of the Wald test, the only possible variation between the monolinguals and bilinguals was that the monolingual groups showed a stronger performance on the language proficiency/verbal reasoning tests than either of the bilingual (early vs. late) groups. This result is puzzling. One possible explanation for this pattern of findings may be related to the language (English) spoken by the majority of monolingual children. Indeed, it is possible that the language proficiency tests employed in this research field may have favored English speakers. The majority of these tests may have been created in order to test English proficiency specifically and then merely adapted into different formats to test speakers of other languages. The largest number of studies (5) were conducted in the U.S. In that case, it is probable that the proficiency and fluency tests would be stronger measurements of English proficiency than of proficiency in other languages.

However, the difference between monolinguals and bilinguals (both early and late) appeared stronger among children from European countries than was the case for the US and Canadian children in the sample. Indeed, among European children the observed difference also appeared to favor the monolingual participants over the bilinguals. Considering that 55% of the bilingual sample spoke English as a second language, the pattern appears to contradict the explanation that the language proficiency tests favored English speakers. In the past, researchers have found controlling for existing differences in bilingual participants to be challenging because bilingual speakers are not a homogenous group, This pattern would certainly be true for monolingual speakers as well, regardless of whether they all speak the same language (Byers-Heinlein, 2014; Valerian 2015).

Thus, an alternative explanation for the observed difference in language proficiency could be group differences regarding the level of achieved parental education. Of the 18 articles I compiled for my analysis, the majority of studies did not test or control for differences in parental education. It is possible that the monolingual participants in European countries came from home environments where the parents had achieved a higher level of education than the parents of the bilingual participants. Therefore, the observed difference in language proficiency which appeared to favor the monolingual participants could be due to parental education.

My second hypothesis was that early bilinguals would show enhanced intellectual processing capabilities when compared to the late bilinguals. This hypothesis was not supported by the results of my analysis. Instead, the results of my analysis show that the age at which a child learns their second language does not make a difference in terms of their intellectual processing abilities and cognitive functioning. This remained true regardless of the first or second language spoken by the participant. The 3 categories of outcomes that I had compiled were stimuli response tests, language fluency/sentence construction tests, and abstract reasoning/nonverbal intelligence tests. An explanation for why the results of my analysis did not support my hypothesis could be that any difference that exists between the two groups (i.e. early bilinguals and late bilinguals), was simply not captured by the measurements of intellectual processing that were compiled for this study.

Alternately, it is possible that age of second language acquisition is not a factor which enhances a child's intellectual processing capabilities. Wiseheart and colleagues (2016) demonstrated that bilingual individuals were more skilled in switching between attentional tasks that were stimulus-response based than were monolingual individuals. However, of the sampled pool of participants, a number were immigrants who became bilingual as a result of immigrating to a new country and becoming exposed to the second language while enrolled in school there. Perhaps then it is not the age at which an individual acquires their second language but the level of second language immersion that takes place. In other words, an individual may achieve a higher level of second language proficiency and this increased proficiency may impact intellectual processing abilities instead of the age of second language acquisition.

**Strengths and Limitations**

Regarding the strengths of my study, I conducted a meta-analysis which synthesized research findings in the field of bilingual education. Prior to conducting the analysis, I found there to be a great deal of inconsistency in the field regarding the differences between monolingual and bilingual speakers and intellectual processing abilities. Indeed, studies with statistical significance can only examine whether findings are likely to be due to chance. On the other hand, effect sizes provide a way to quantify the difference between two groups by emphasizing the size of the difference rather than confounding this with sample size (a common problem with tests of statistical significance). Indeed, after conducting my analysis, examination of the fail-safe N indicated that a minimum number of 482,418 additional studies would be needed to change the conclusions of my meta-analysis. Due to the fact that this is such a large number of additional studies, I can be confident that the conclusions of this analysis were not subject to publication bias.

Regarding the limitations of my study, the fact that I chose to create three categories for intellectual processing abilities means that it is possible distinctions about the individual types of skills underlying the tests were lost. In other words, if there is variation in cognitive functioning regarding the measurements of intellectual processing abilities included in my analysis, the quantifying of the data into three parsimonious categories may have led to nuances in the outcomes being lost.

# Conclusion

I had two research objectives. The first research objective was to identify whether bilingual speakers benefit from enhanced intellectual processing abilities compared to monolingual speakers. The second research objective was to identify if early second language acquisition benefits children's intellectual processing abilities more than late second language acquisition. The key question I wanted to answer was does early second language acquisition benefit children's intellectual processing abilities more than late second language acquisition? I searched electronic databases such as PsycINFO and PsycArticles in order to identify studies that reported quantitative associations between second language acquisition and enhanced intellectual processing abilities. I found 18 research articles (20 studies) that achieved all of my criteria. From these 18 articles, I synthesized evidence from 20 different studies on the associations between onset-age of second language acquisition with cognitive outcomes of being bilingual. The mean age of early second language acquisition was 4 years with the oldest age being 7.7. The mean age of late second language acquisition was 9.4 years with the oldest age being 15.9.

My first hypothesis was that both early bilinguals as well as late bilinguals would show enhanced intellectual processing capabilities when compared to the monolinguals. The results of my analysis did not support the hypothesis. My second hypothesis was that early bilinguals would show enhanced intellectual processing capabilities when compared to the late bilinguals. Again, the results of my analysis did not support the hypothesis. Indeed, according to my analysis, the age at which a child learns their second language does not make a difference in terms of their intellectual processing abilities and cognitive functioning. Regarding the strengths of my study, examination of the fail-safe N indicated that a minimum number of 482,418 additional studies would be needed to change the conclusions of my meta-analysis. Due to the fact that this is such a high number, I am confident that the conclusions of my analysis are not subject to publication bias.

**Implications for Future Research**

Future research that is conducted in the field of bilingual education and second language learning should focus on a larger sample of studies from countries outside of North America and Europe. This would help researchers to better understand regional or geographic differences regarding second language acquisition and measurements of intellectual processing abilities. Moreover, there could be regional and geographic differences regarding the level of second language immersion that takes place. For certain educational systems, students in foreign language courses may be required to travel to other countries in order to better immerse themselves in the second language. Thus, perhaps a higher level of second language proficiency may impact intellectual processing abilities even if age of second language acquisition is not a factor.

It would also be beneficial for future researchers to assess different outcomes between monolinguals and bilinguals or early and late bilinguals. Future researchers could synthesize comparisons using different measurements of intellectual processing abilities that were not captured in this meta-analysis. Additionally, I think future studies should test and control for group differences in parental education. It is possible that the level of achieved parental education could be a factor which impacts the intellectual processing capabilities being measured. Finally, another interesting avenue to research would be the effect that bimodal bilingual would have on intellectual processing abilities, as this study merely focused on spoken languages.

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