Languages and Intellect:

Fluency in languages and intelligence

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Introduction

Intellect is recognized as a form of reasoning and objective understanding, in often cases related to the realms of abstract thought or academia. Intellect is a factor in a wide series of studies ranging from collective intelligence to genetics, and various other topics that fall under the complex umbrella that is intellect. The study that I conducted in particular narrows in on intellect as a dependent variable when taking into consideration the amount of languages a participant is fluent in. Ultimately, what I sought out to find in my research is if there is a difference in intellect for multilingual individuals when compared to monolingual individuals. This question interests me personally as a bilingual individual, and in a more societal context, many schools have begun including immersion programs at a young age so that children may be bilingual, I wanted to find support to the concept that there is an academic advantage in being fluent in more than one language.

I predict that being fluent in more than one language would be a factor in explaining a higher intellect due to the fact that certain studies have supported the claim that fluency in more than one language can be linked to better memory and cognitive ability, as well as through personal experience with bilingual peers. Reference the table below for the summation of my null and alternative hypotheses.

	H1	H2
Null Hypothesis	The amount of languages an individual is fluent in has no effect on their intellect; multilingual individuals will not score higher on an intellect scale.	The amount of languages an individual is fluent in would not have an effect on their intellect when controlling for their level of education.

Alternative Hypothesis	The amount of languages an individual is fluent in does have an effect on their intellect; multilingual individuals will score higher on an intellect scale.	Multilingual individuals will have a higher scaled intellect score when controlling for their level of education.

As intelligence may be a difficult variable to measure accurately and cross-culturally, a series of psychologists have tested the intelligence tests themselves, seeking accuracy and reliability within the tests so that they may be utilized in further research. For example, there is James Cooper's study in which he tested if intelligence examinations accurately predicted academic achievement for bilingual pupils in Guam. The intellect exams utilized were actually sourced from California School Achievement exams given regularly to students of California. The six exams tested were: Davis-Eells Games, Intermediate Level, .53; Culture Free Intelligence Test, Scale 2, Form A, .55; Columbia Mental Maturity Scale, .61; California Test of Mental Maturity, 1950 S-Form, Elementary, .64; Leiter International Performance Scale, .66; and the Wechsler Intelligence Scale for Children . These six intelligence tests specifically examined in regard to the bilingual student community in this study were able to predict school success with an accuracy ranging from moderate to high for Guam's bilingual students, proving their validity (Cooper, 1958).

Another study that focused on college grades as a way to measure cognitive advantages in bilingual students, although it may be argued that attaining good grades may not necessarily be synonymous with intelligence. In this experiment, 40 students with the ability to speak and understand another language alongside English were paired with students who spoke only English based on exam scores and college level. Ultimately, this study, conducted primarily by

Marshall and Phillips, actually disagreed with my general inference, concluding that overall, bilingualism does not affect success in college (Marshall & Phillips, 1942).

A study conducted by Christian Lemmon and Judith Goggin, sought to find a correlation between bilingualism and cognitive ability. This study compared performances of monolinguals and bilinguals on cognitive ability tasks. The tests that were ran for each participant involved concept formation, mental reorganization, abstract and divergent thinking, and mental flexibility. They confirmed their hypothesis that the two language storage systems have an interdependence in the cognitive ability of bilinguals (Lemmon & Goggin, 1989), in simpler terms meaning that the effects of the memory and thought processes associated with multilingual individuals do bleed through into their cognitive ability, and both the storage system for their memory as well as their cognitive ability rely on one another.

A fairly recent study, published in 2016, compared bilingual and monolingual Iranian university students in tasks of executive function. This study focused more specifically on early bilingual students, meaning primarily students who were raised speaking more than one language from a young age. Their results regarding the early bilingual participants were consistent with the possibility that individuals who began speaking a second language earlier in childhood have greater advantages in the realm of executive function, due either to effects of acquiring a second language earlier or to a longer duration of bilingual experience. Their results provided evidence of advantage in executive function in early bilingual students vs. monolingual students. Their analyses also supported the idea that early bilingual students have better performance in working memory than monolingual students (Kazemeini & Fardardi, 2016).

A study on the correlation between dual coding and bilingual memory was also read in preparation for conducting my own research study. This article focused on the effects of bilingual dual coding on memory and recall. It compared memorization when based on a nonverbal, image based method with monolingual individuals, and a bi-verbal method with those fluent in more than one language. The relevance of this article in regard to my study lays in the fact that it showcases a difference in human information storage in bilinguals juxtaposed to monolingual individuals. This could attest to a higher score on an intellect scale, which is what I sought to find out (Pavio & Lambert, 1981).

Another study that focused on multilingual and monolingual minds had to do with the specific effects of repeated readings on bilingual and monolingual memory for text. Across 4 experiments, 221 college students read narrative texts and answered the comprehension questions that followed. Whether their time between repetitions was massed or spaced, the language of their repetitions (same or different), and whether the type of activity between the 2 repetitions was interfering or non-interfering passages was manipulated. These variables affected performance only when regarding details of specific texts, not as much with the main ideas behind the presented texts. It was found that a spaced repeated reading led to better performance than a massed repeated reading. However, interestingly enough, a bilingual presentation was found to be able to overcome the disadvantages of a massed repetition. This article holds relevance in regard to my own study due to the fact that the psychologists worked specifically with college aged students, as the majority of my participants tended to be, and it had results that supported the advantage of bilingual presentation in repetitive readings for memorization (Durgunoglu & Arino-Marti, 1993).

Immigrating and emigrating amongst nations has resulted in a mix of culture, language, and identity amongst individuals in society. Knowing how to speak more than one language may have advantages beyond being able to connect with other individuals, it may very well allow you to have a higher intellect and perform better cognitively. The introduction of immersion programs early on in a child's academic career worldwide is in part due to the advantages being multilingual in today's world holds. Although this is not a concept that has never been studied, humans develop and change in many ways, and a fresh, relevant look at this question may provide new results.

Methods

A survey consisting of 15 items was sent out on social media platforms as well as text messages to known individuals, which were then relayed to their friends, to find participants for this study. The message in attempt of recruitment read: "If you have a minute to spare, please take this anonymous survey for my data analysis course. I'd really appreciate it!" No direct incentive other than appreciation was offered to participants for recruitment, the ways that this may have limited my study are discussed further in the discussion section. 51 surveys were collected, as no outliers were found, all 51 participants remained in the study. The participants consisted of 19 males (37.25%), 32 females (62.75%), and 0 of other gender/sex (Table 1a.); the participation based on age ranges are as follows: 18-24 (72.55%), 25-34 (17.65%) , and 35+ (9.80%), this data is shown in Table 1b. The BFAS Intellect Scale (alpha = .84) was utilized to get a scale score of intellect for all individuals participating, this consisted of questions along the lines of: "I like to solve complex problems.", to which the participants responded on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The survey considered a series of demographic

questions along the lines of what gender the participant identifies with, their age within a provided age bracket, what term best described the area they live in: urban, suburban, or rural (Table 1c.), as well as their level of education. The category in which the participants were placed for the study, monolingual or multilingual, was based on their response to the question of whether the participant spoke one or two+ languages. All of the data cleaning and data analysis was performed in *R*. The first response considered by the R software was the question being asked of the participant, so the first response for each question was indexed and removed. The survey did not include self-input data, and all non-categorical questions drawn from the BFAS Intellect Scale was mandatory, by which I mean the participant must have completed each component of the scale to complete and be considered in the study.

The experiment was all done online, and took the average participant no more than 3 minutes. Their responses were anonymous and recorded within the *Qualtrics* site for UC Berkeley students. The independent variable was the number of languages spoken, measured by having each participant mark the category of either 1 or 2+, for which I observed the dependent variable, the overall scaled intellect score, based on the average of the 10 intellect questions asked of each participant. The control variable was the level of education of each participant, I measured that through a self report question where the participant marked what level of schooling they were currently in or have accomplished: High School, 1st year undergrad, 2nd year undergrad, 3rd year undergrad, 4th year undergrad, and Graduate School +.

Results

In this analysis, the monolingual group was the baseline group and the multilingual group was the comparison group. The initial bivariate model was meant to find a difference in intellect between the monolingual and multilingual groups, and the data did support the hypothesis of this study in that there would be a difference in intellect found between the two categories.

The descriptive statistics for the dependent, continuous variable: Intellect, can be found in Table 3. The frequencies of all other variables that were measured in this study can be found in the Tables section as well, all demographic measures within Tables 1a-1c, as well as the results of the control variable in Table 2. The results of the Interaction effect measured can be found in Table 4.

I tested a linear model predicting a scale score of intellect from whether the participant spoke one language or two or more. I found a significant relationship between number of languages spoken and intellect. Participants who spoke more than one language tended to score higher in intellect ($b = 0.4$, 95% CI = [.14,.74] , $t(51) = 2.9$, $p = .005$). The number of languages spoken explained around 15% of the variance in intellect score – a significant amount ($F(1,49) = 8.8$, $p = .005$). The power of the model of the main hypothesis was .113, meaning there was about 11.3% power to detect an effect if there is one.

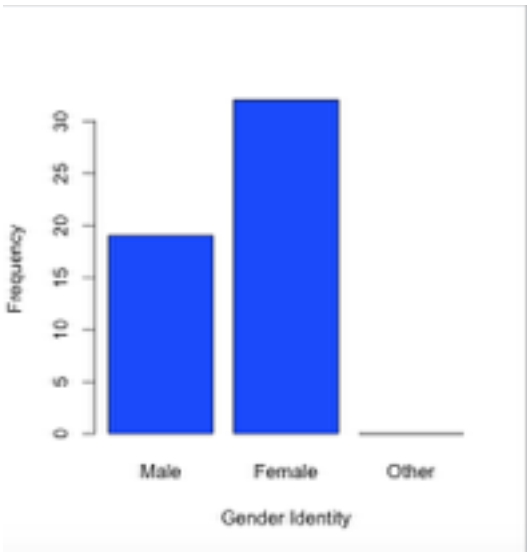
As a control variable, I had participants signify what year of schooling they were either currently enrolled in or have accomplished in their lifetime, the results of this question are found in Table 2. Level of education is generally recognized as a form of increasing or detecting a certain level of intellect, so I created a model to predict a scale score of intellect from what year of schooling the participant has accomplished. With high school graduate set as the reference

point, there seemed to only be a significant, positive relationship for those either currently enrolled in or who have accomplished four years as an undergraduate (b=.6, 95% CI = [.015, 1.17], t(51) = 2.1, p = .045). The year of schooling explained around 11% of the variance in scaled intellect score, which is not considered a significant amount (F(4,46) = 1.4, p = 0.25).

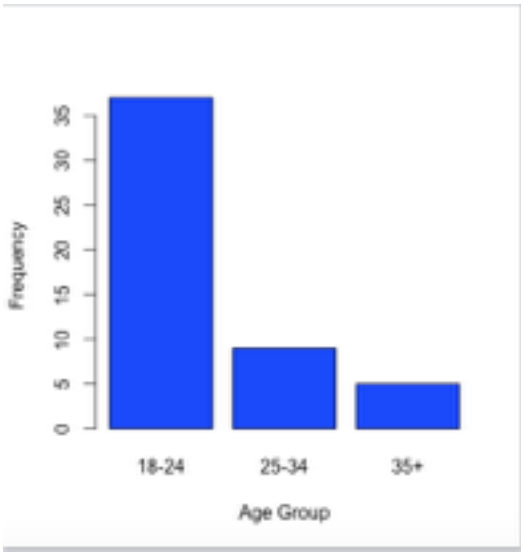
Finally, I tested a multivariate model to test for any confounds, in this model I incorporated both the fluency in one or more language of the participant with their level of education in order to measure their intellect. It seems as though those who are fluent in more than one language still maintain a significant positive slope, although the slope slightly increased (by ~.1) so what I had initially thought of as a unique effect, may actually be better described as a partial mediation effect (b=.56, 95% CI= [.18,.68], t(51) = 3.7, p = .001). The partial mediation is also found for fourth year undergraduate students which maintained a positive slope in intellect, also having roughly .1 increase in slope juxtaposed to the original model (b=.66, 95% CI = [.10,.60], t(51) = 2.6, p = .01). The multivariate model showed a significant positive slope for the second (b=.52, 95% CI = [.03,.9], t(51) = 2.1, p = .04) and third year undergrad (b=.75, 95% CI = [.27,1], t(51) = 3.2, p =.003) students as well, meaning that there was a suppressor effect within the data of those two categories. The combination of languages spoken with level of education explained around 31% of the variance in intellect score, which is considered a significant amount (F(5,45) = 4.1, p = .004). This would suggest that the combination of how many languages an individual is fluent in along with how many years of schooling they have accomplished would be a far better method to predict intellect than a bivariate model between languages spoken and intellect could alone.

Tables & Figures.

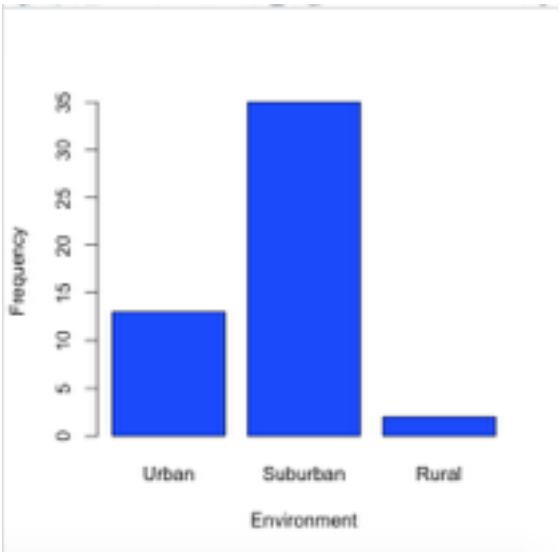
Graph 1: Gender



Graph 2: Age

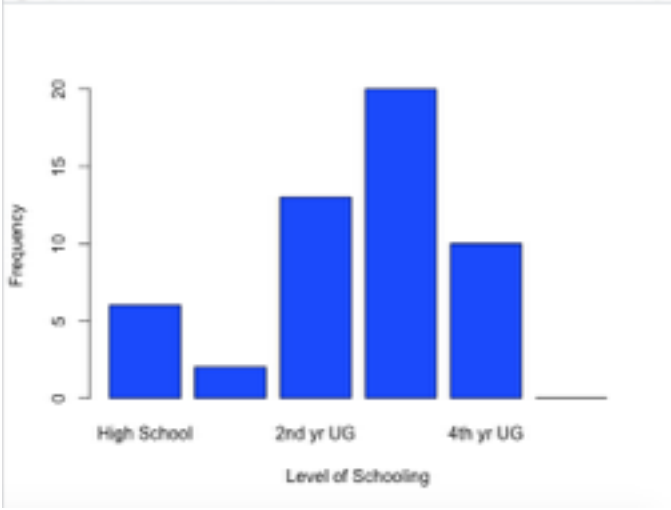


Graph 3: Environment

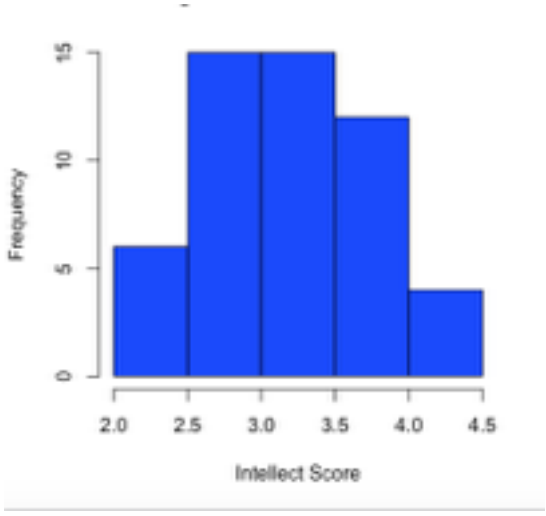


Graph 4: Languages Spoken

Graph 5: Education

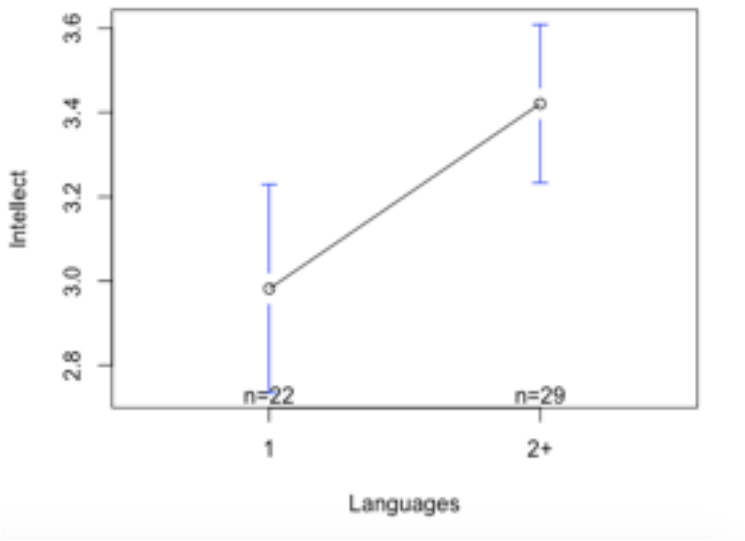


Graph 6: Intellect

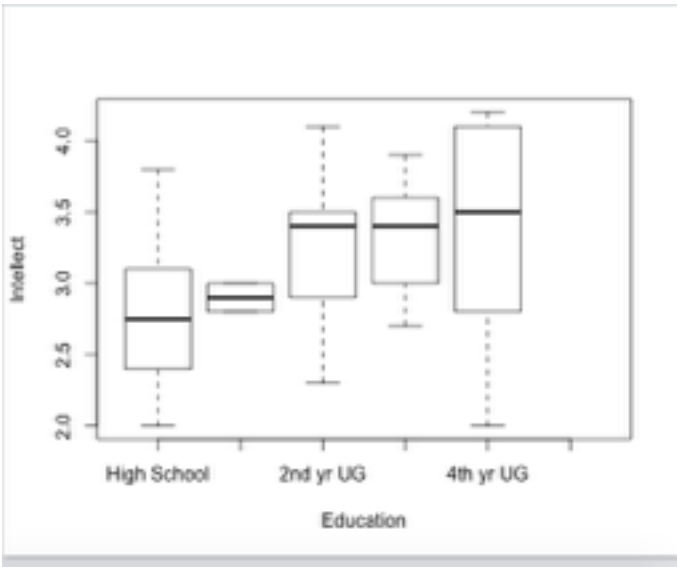


Graph 7a: Languages & Intellect

Graph 7b: Languages & Intellect



Graph 8a: Languages & Education



Graph 8b: Languages & Education

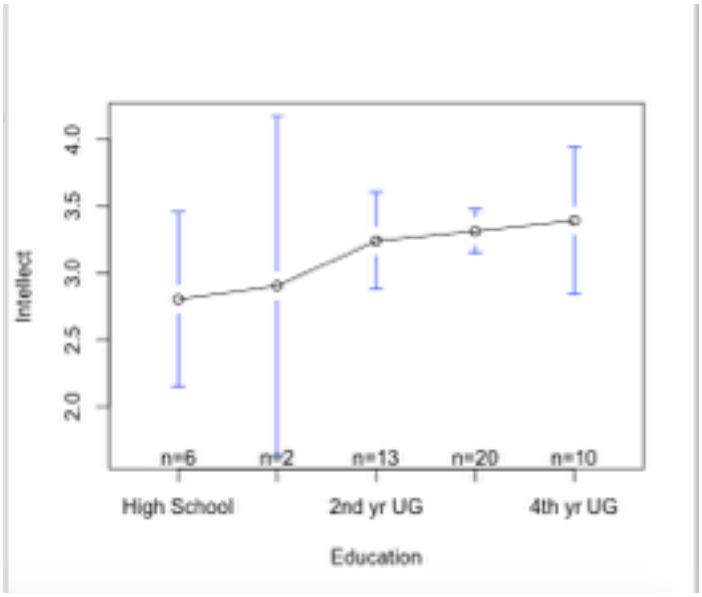


Table 1a. Demographics—Gender Identity (n = 51)	**Male**	**Female**	**Other**
	19 Participants 37.25%	32 Participants 62.75%	0 Participants 0%

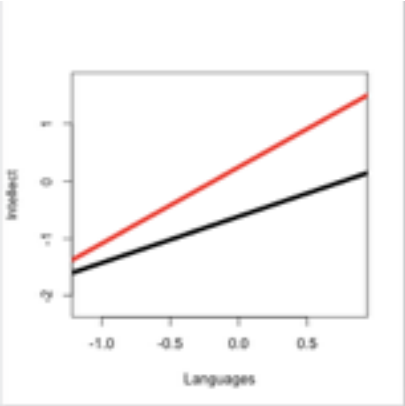
Table 1b. Demographics—Age (n = 51)	**18-24**	**25-34**	**35+**
	37 Participants 72.55%	9 Participants 17.65%	5 Participants 9.8%

Table 1c. Demographics—Environment (n = 51)	**Urban**	**Suburban**	**Rural**
	13 Participants 26%	35 Participants 70%	2 Participants 4%

Table 2. Control—Education	High School Graduate	1st year Undergrad	2nd year Undergrad	3rd year Undergrad	4th year Undergrad	Graduate school +
	6 Participants 11.76%	2 Participants 3.92%	13 Participants 25.49%	20 Participants 39.22%	10 Participants 19.61%	0 Participants 0%

Table 3. Descriptive Stats for Continuous Variable (Intellect Scale)	Mean	Standard Deviation	Range	Alpha	Median	Minimum	Maximum
	3.23	0.56	2.2	0.76	3.3	2	4.2

Table 4. Interaction Effect.



Standardized Betas

	Model 1	Model 2	Model 3	Model 4
Estimated Effects				
Languages	.39 [.13,.66]		.43 [.18,.68]	.43 [.18, .69]
Education		.32 [.04,.59]	0.35 [.10,.60]	.39 [.13,.65]
Languages*Education				-.124 [-.4, .15]
Model Summary				
R^2	0.15	0.10	0.28	0.29
F-Test	(1,49)	(1,49)	(2,48)	(3,47)

Discussion

Those who were categorized as multilingual were found to score higher on their intellect score than those who were monolingual on average. There could be a series of explanations for this finding. First, as in all experiments and studies performed, random chance is a factor that could influence results to appear a certain way or cause some form of error in conclusions. Beyond random chance, other possibilities could be along the lines of the validity of the tests utilized for the study, as Cooper's study attempted to minimize the effects of such an error. As previous studies have shown, those who are fluent in more than one language may be considered to have a greater ability of memory retention, as well as ability to preform better cognitively, both of these conclusions would support the idea that multilingual individuals would test better overall on an intellect scale. As Kazemeini found, the difference in scored intellect may be explained by the cognition necessary at a young age to maintain early bilingualism, which may have trained the mind in a way that differs from monolingual individuals as they grow old.

Limitations and Future Directions

My research had several limitations. Firstly, my sample size was relatively low, and generally speaking, the larger the sample size, the more accurate to reality the results of your analysis. As a result of sending out the survey to people either friends with myself on social media or who I have mutual friends with, my sample was a convenience sample that was highly saturated with UC Berkeley students. An intellect score of students at a top university might not be the most representative of people of similar demographic backgrounds on a global level. Another limitation in my study is the fact that intelligence is more complicated than an earned

score on an intellect scale. Human beings are far too complex to be able to label a certain degree of intelligence based on a series of questions regarding abstract thought. A future study may find a better way to assess intellect that may be more focused on cognition and memory more so than a ranking of how much the participants enjoys difficult reading material or how they rank their vocabulary.

A future design on a similar research survey could put more of an effort in ensuring participants are from a wider array of individuals and more randomized by posting through public websites, and they could also improve the number of their sample size by possibly including more of an incentive in return for the few minutes of the participants' time than a thank you—possibly putting names of participants into a raffle for a specified prize, or providing some sort of monetary compensation.

In hindsight, I would not have made the variable of age into a category and would suggest a future researcher ensure it is measured as a numeric value. I would make this suggestion based on the fact that individuals do tend to be recognized as more wise with age as they go through trials and tribulations, and intellect could possibly be correlated with how old a participant is. Also, if publication is an intention of the researcher, many journals would require age to be considered a numeric, continuous variable.

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