STCS CONSULTING REPORT FOR PROJECT "LANGUAGE ATTITUDES AMONG LEARNERS OF FRENCH"

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1. Introduction

Language attitudes that reflect social hierarchies have been reproduced by higher education institutionally, which influence students' perception and learning of a language. The French-language education in Canada provides a great number of such cases due to the abundant varieties of French spoken in Canada. Particularly, French learners in Canada are likely to demonstrate more interest in learning the European variety of French that is considered to be standard by them.

In this study, 94 subjects are recruited by Professor Marie-Eve Bouchard to participant in an online survey to evaluate their attitudes toward language. After having related background knowledge of survey participants collected through a questionnaire, participants listened to 10 young women speaking in French and rated the recordings on a Likert scale. The main objective of this study is to examine the processes of hierarchization of different French varieties of Canada and possible impacts of the perception of racialized individuals on the understanding of a linguistic message.

This report intends to provide statistical analyses of the collected dataset. The report is organized as follows. The exploratory data analysis presented in Section 2 will shed light on some initial empirical results. Section 3 will provide confirmatory analyses to validate the results from Section 2. Repeated measures ANOVAs and pairwise t-tests will be performed to compare the difference among groups of accents in different dimensions. Two-sample t-test and Wilcoxon test will be conducted to assess the differences that potentially exist in participants' perspectives toward speakers of different races. More specifically, a two-way ANOVA is used to assess the existence and significance of the interaction effect between race and accent, and the result will be validated by a linear mix effect (LME) model and generalized estimating equation (GEE) model.

2. Exploratory Data Analysis

An overview of the dataset is provided to facilitate the reading of the following analyses. Furthermore, statistical tests are implemented to seek potential associations between the response and explanatory variables.

2.1. **Overview of Dataset.** Variables included in the following analyses are depicted in Table 1. Since every participant will listen to 10 speakers and answer 10 rating questions, there are 100 ordinal columns in total. For the convenience of calculating, the original scale will be replaced with a six-point, Likert-like scale (1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree, 6 = strongly agree). Considering the weak accent is more likely to be a representation of positive feedback, the scale of the original question "strong accent" is reversed. In addition, the data will be transformed into a longitudinal format to incorporate the information of speakers (race and accent). Meanwhile, columns for their race and accent will be appended correspondingly.

Date: December 2021.

Regarding data missingness, there is a small portion of missing values in the demographic columns such as gender and age, while there doesn't exist any data missingness in the recording evaluation columns. Despite that the data may be missing at random, imputation is not considered here because the focus of the analysis will be placed on the recording evaluation part.

Variable	**Type**	**Range/Level**
Gender	Factor	Female, Male, Prefer Not to Reveal, Unknown
Age	Numeric	17 - 44
Country of Birth	Factor	Canada, China, Ukraine, ...
Grown up Province (in Canada)	Factor	British Columbia, Ontario, ...
Number of Spoken Language(s)	Numeric	1 - 4
Spoken Language(s)	Factor	English, French, Cantonese, ...
First Language(s)	Factor	English, Mandarin, Tagalog, ...
Year(s) of Speaking French	Numeric	1 - 25
Residence in French-speaking	Factor	Québec, France, Tunisia, ...
Month(s) of Residence in French-speaking Areas	Factor	<1, 1 - 3, 4 - 6, >12
Preferred Type of French to Learn	Factor	French from France, French Québec, No Preference
Origin(s) of French Teacher(s)	Factor	France, Québec, Switzerland, ...
Evaluation of Recordings	Ordinal	Strongly disagree, Disagree, Slightly Disagree, Slightly Agree, Agree, Strongly Agree

TABLE 1. Description of Variables

2.2. **Participant Portrait.** Usable data are collected from 94 UBC students in early September 2021. The overall subject sample contains more than twice as many females (72%) than males (26%). It is demonstrated in Figure A.2 that the mean age of participants is 20.4 years, with a relatively wide range of $17 - 44$. Classifying by the country of birth, 52 participants were born in Canada, and 42 were not. Out of 52 born-in-Canada people, a majority of them are grown up in British Columbia (40). For people who were not born in Canada, a great proportion of them are from Asia (32), which is followed by America (6) and Europe (4). Based on the participants' self-reflection on their language background, most of the participants are either bilingual or multilingual. Specifically, 1 person speaks only one language, 28 people speak two languages, 51 people speak three languages, and 12 people speak four languages. For the first language, observing the top 3 bars in Figure A.3, 51 people whose first language is English, 14 people whose first language is Mandarin, 9 people whose first language is Cantonese. There are 20 languages reported as a first language in total, and some participants report more than one language as their first language.

For French studies, 12 people declare French as their field of study. The years of learning French vary across groups (Figure A.4), with $10 - 15$ years $(21; 38\%)$ being the most common length of learning French, which is followed by $0 - 5$ years $(14; 25\%)$, $5 - 10$ years $(14; 25\%)$, and > 15 years $(7; 12\%)$. For their French teachers, 48.9% of participants are taught by teachers from France, 25.5% are taught by teachers from Québec, 4.3% are taught by teachers from both France and Québec, 19.1% are taught by teachers from elsewhere, and the remaining ones did not reveal. When asked their preferred type of French to learn, French from France is favored by a majority of 59% of participants, and 32% indicate no specific preference. Only 7% of participants prefer to learn French from Québec.

For residence in French-speaking places, the participants were divided into four groups: 34.9% have lived in Québec, 23.9% have lived in France, 2.8% have lived in other French-speaking countries, and 38.5% did not answer the question. Among 67 participants who have lived in French-speaking places, 34% spent $4-6$ months there, which is followed the groups of > 12 months, < 1 months, and $1-3$ months.

2.3. **Statistical Tests: Language Attitudes vs. Accents.** Recordings employed for this matched-guise experiment are with the following accents: European, Québec, Acadian, African, and English. Participants will evaluate each recording by answering 10 rating questions. To facilitate the comparison when investigating the impact of accent on participants' language attitudes, ten ratings will be divided into four dimensions:

- *General Perspective*: Beautiful French
- *Solidarity dimension*: Dynamic, Nice, and Social
- *Status traits*: Professional, Leadership, and Educated
- *Understandability*: Easy to Understand, Good French Teacher, and Weak Accent

After combining the ratings of speakers with the same accent, repeated measures ANOVAs will be conducted. The repeated measures ANOVA is used for analyzing data where the same subjects are measured more than once. To ascertain statistically significant differences, paired t-tests between the levels of the within-subjects factor, which is accent in this study, are adopted. P-values are adjusted using the Bonferroni multiple testing correction method.

2.3.1. ***Attitudes on General Perspective and Solitary Dimensions.*** Table 2 presents the results of ANOVAs that were performed to establish attitudes among five accents on general perspective and solitary dimensions. For the general perspective of whether a certain accent is considered to be "beautiful", it appears that the participants held more favorable attitudes towards European French and Québec than another three accents. Furthermore, even though the mean score of European French is slightly greater than that of Québec French, it can be observed from Figure A.4 that the difference of participants' general impression of two accents is not statistically significant. (Note: there will not be a square bracket above if the relationship is not statistically significant). For three solitary dimensions, European French and Québec French remain the top two accents with the most positive feedback from participants, and Québec French received slightly more positive evaluations from the participants. As evidenced by Figure A.4, again the difference between these accents is not statistically significant in three solidarity dimensions. For another three accents, they follow the same order in all solitary dimensions: English, Acadian, then African.

	μ_{Acadian}	μ_{African}	μ_{English}	μ_{European}	$\mu_{\text{Québec}}$	F	p
Beautiful French	6.8	7.7	8.0	10.6	10.3	88.5	2.24e-43
Dynamic	7.3	6.1	7.7	9.4	9.8	99.7	3.93e-50
Nice	8.6	7.8	9.0	9.5	9.7	32.8	4.07e-19
Social	8.2	7.1	8.7	9.5	9.9	67.3	1.18e-35

TABLE 2. Results of Repeated Measures ANOVA on General Perspective and Solitary Dimensions

2.3.2. ***Attitudes on Status Traits.*** Table 3 includes the findings of repeated measures ANOVAs that were performed in terms of status traits, and Figure A.5 demonstrates the distribution of scores of each accent and results of pair-wise t-tests. The results reveal that Québec French were rated slightly more favorably than the European French in the aspects of professionalism and leadership with no statistical significance, and received roughly equal positive feedback with European French in terms of education, which does not necessarily mean that the participants simply evaluated these two accents equally favorably. For the rest three accents, the English accent had the best performance in three traits. It is worth attention that the African accent received far more negative attitudes than other accents in the traits of leadership, which is statistically significant.

	μ_{Acadian}	μ_{African}	μ_{English}	μ_{European}	$\mu_{\text{Québec}}$	F	p
Professional	7.2	7.4	8.1	9.9	10.0	69.4	2.26e-33
Leadership	7.2	6.5	7.6	9.4	9.7	88.1	8.99e-42
Educated	7.6	7.8	8.3	9.9	9.9	59.2	1.51e-26

TABLE 3. Results of Repeated Measures ANOVA on Status Traits

2.3.3. ***Attitudes on Understandability.*** As evidenced by Table 4, the English accent and Québec accent are the easiest to understand, which is followed by the European accent, African accent, and Acadian accent. Figure A.6 reveals that except for the pair-wise difference between English accent and European/Québec accent, any remaining pair-wise differences are all statistically significant. For the potential to be a good French teacher, speakers with Québec accent and European accent are the most favorable compared to other accents with statistical significance. However, the difference between the Québec accent and the European accent is not of significance. For weak accents, participants are more likely to vote for English accent. Particularly, participants tend to consider European French has a weaker accent than Québec French, but the difference is not statistically significant.

	μ_{Acadian}	μ_{African}	μ_{English}	μ_{European}	$\mu_{\text{Québec}}$	F	p
Easy to Understand	7.4	7.5	10.0	9.3	9.9	57.9	8.51e-30
Good French Teacher	5.8	6.4	7.3	9.7	10.3	117.1	5.69e-51
Weak Accent	5.5	6.0	7.0	6.7	6.4	6.4	8.41e-04

TABLE 4. Results of Repeated Measures ANOVA on Understandability

2.4. Statistical Tests: Language Attitudes vs. Race.

2.4.1. ***Two-sample t-test and Wilcoxon Test.*** To investigate if participants held significantly more positive attitudes toward white speakers compared to black speakers, a paired one-sided two-sample t-test and one-sided Wilcoxon test are conducted. The results are presented in Table 5. As shown in Table 5, the p-values from both tests are smaller than 0.05, which is a signal indicating that the difference between two groups is statistically significant.

	Alternative Hypothesis	**Test Statistics**	**p**
Paired t-test	True difference in means >0	3.42	0.0003
Paired Wilcoxon Test	True location shift >0	53625	0.0044

TABLE 5. Paired T-test and Wilcoxon Test between the Group of Black Speakers and the Group of White Speakers

2.4.2. ***Two-way Repeated Measures ANOVA.*** To evaluate simultaneously the effect of two within-subject factors – the accent and race of speakers on participants' attitude, two-way repeated measures ANOVA will be performed. The result is summarized in Table 6, which shows that the levels of accent are associated with significantly different strengths, as well as the levels of race. For the interaction term, its p-value reveals that there is a significant interaction effect between the accent and race of speakers, which means that the effect of accents on participants' language attitude will depend on the race of speakers. Since we have a statistically significant interaction, reporting the main effects can be misleading. Instead, the simple main effects will be the alternative, which is the differences among particular group means within the design. Paired t-tests are employed to decompose the effect. It is demonstrated in Figure 1 that the mean evaluation score of black speakers is significantly greater than that of white speakers in the groups of Acadian, Québec, and African accents. For the groups of European and English, in spite of no statistical significance, the mean scores of black speakers are also greater than those of white speakers.

Effect	**F-statistics**	**p**
Accent	131.6	4.79e-50
Race	39.01	1.25e-08
Accent, Race	10.67	3.37e-08

TABLE 6. Results of Two-way Repeated Measures ANOVA on Race and Accent

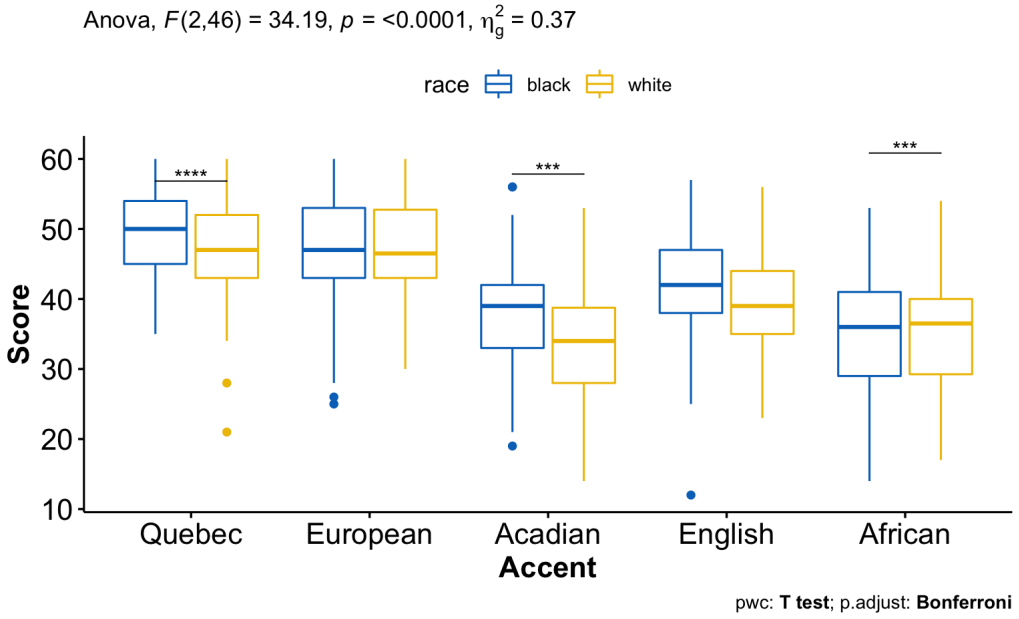


FIGURE 1. Repeat Measures ANOVA on Race and Accent

3. Confirmatory Data Analysis

To validate the results from exploratory data analysis, a linear mixed effect (LME) model and GEE model will be applied and compared in this section. The race and accent of speakers, along with their interaction term, will serve as explanatory variables, and the evaluation score will be the response variable in the models.

3.1. **LME Model.** A linear mixed effect (LME) models can be thought of as a trade-off between noisy individual regressions and less-noisy aggregate that may lose important differences by averaging samples, which are an extension of simple linear models to allow both fixed and random effects. It has been found in the two-way ANOVA there is signification interaction effect between the race and accent of speakers. If the changes in the level of one predictor result in different changes in the value of the response variable for the different levels of the other predictor, we say that there is an interaction effect between these two predictors, which is common in regression analysis. In this study, it is expected to establish a relationship in the following form:

$$score_i = \beta_0 + \beta_1 race_i + \beta_2 accent_i + \beta_3 race_i * accent_i + \varepsilon_i \tag{1}$$

where race is a binary variable with two levels (black and white), and accent is a categorical variable with five levels (European, Québec, Acadian, English, and African). Taking multiple measures over one participant violates the assumption of independence in simple linear regression models because multiple responses from the same participant cannot be considered to be independent from each other, which explains the poor fit and extremely small R^2 when using a linear regression model in this study. On one hand, diverse backgrounds of participants result in variations between individuals. But on the other, participants can also be clustered in some other grouping like their first language, origins of their French teachers, and preferred type of French to learn. To summarize, we have large variations between individuals and there may also exist correlations among subjects, which suggests that an LME model may be appropriate and give useful insights in this study.

To determine the choice of random effect for the LME model, a simple linear model is built for each participant to check how the estimates vary across individuals based on a 95% confidence interval. It is demonstrated in Figure A.8 that random effect may be required for both intercept and slope in the linear mixed effect model because many confidence intervals in the plots do not overlap. To reach a more rigorous decision, a random intercept model, a random intercept and slopes (race and accent) model, and a random intercept and slope of accent model are fitted. After conducting an ANOVA on these three models, the model with random effect on intercept and slope of accent has the lowest AIC and BIC value. Moreover, the likelihood ratio test returns a significant result ($p < 2e - 16$) for this model. Hereby a random intercept and slope of accent model will be adopted:

$$score_{ij} = (\beta_0 + \nu_{0i}) + \beta_1 race_i + (\beta_2 + \nu_{2i}) accent_i + \beta_3 race_i * accent_i + \varepsilon_{ij} \tag{2}$$

where β_0, β_1, and β_2 are fixed effects, and ν_{0i} and ν_{2i} are random effects. In terms of model assumptions, besides the assumption of large between-individual variations, an LME model should also satisfy the assumptions including the normality of residuals and homogeneity of variances of residuals, which have been verified and the results are shown in Figure A.9.

The results of the LME model is summarized in Table 7. Having white spkeakers and European accent as references, it is shown in Table 7 that there are four interaction terms, which are black speakers with Acadian accent, black speakers spoke with African accent, black speakers with English accent, and black speakers with Québec accent, among which only the effect of black speakers with African accent are not significant. To obtain a thorough understanding, the interpretation of each of the terms (fixed effects) in the model is provided below:

- b_0 **(intercept)**: the intercept, or the predictor evaluation score when a white speaker speaks European accent

- b_1 **Race: black**: the simple effect of black speaker speaks European accent. Namely, it is the *black - white* evaluation score in the group of European accent
- b_2 **Accent: Acadian**: the simple effect of white speaker speaks Arcadian accent. Namely, it is the difference in evaluation score between Acadian accent versus European accent for white speakers
- b_3 **Accent: African**: the simple effect of white speaker speaks Arcadian accent. Namely, it is the difference in evaluation score between African accent versus European accent for white speakers
- b_4 **Accent: English**: the simple effect of white speaker speaks Arcadian accent. Namely, it is the difference in evaluation score between English accent versus European accent for white speakers
- b_5 **Accent: Québec** : the simple effect of white speaker speaks Québec accent. Namely, it is the difference in evaluation score between Québec accent versus European accent for white speakers
- b_6 **Race: black * Accent: Acadian**: the interaction effect of race black and the Acadian accent, which is the race black effect (black – white) in the Acadian accent versus the race black effect in the European condition. Also, it is the Acadian accent effect (Acadian – European) for black speakers versus the Acadian accent effect for white speakers.
- b_7 **Race black * Accent: African**: the interaction effect of race black and the African accent, which is the race black effect (black – white) in the African accent versus the race black effect in the European condition. Also, it is the African accent effect (African – European) for black speakers versus the African accent effect for white speakers.
- b_8 **Race: black * Accent: English**: the interaction effect of race black and the English accent, which is the race black effect (black – white) in the English accent versus the race black effect in the European condition. Also, it is the English accent effect (English – European) for black speakers versus the English accent effect for white speakers.
- b_9 **Race: black * Accent: Québec** : the interaction effect of race black and the Québec accent, which is the race black effect (black – white) in the Québec accent versus the race black effect in the European condition. Also, it is the Québec accent effect (Québec – European) for black speakers versus the Québec accent effect for white speakers.

Generally, the coefficients of the combination b_6, b_7, b_8 and b_9 are difficult to interpret. If explaining in plain English, for example, b_6 can be seen as the additional black speaker effect of going from European accent to Acadian accent, and b_9 as the additional black speaker effect going from European accent to Québec accent.

	Dependent variable:
	Evaluation Score
(Intercept)	47.128^{***}
	(0.716)
Race: black	-0.213
	(0.592)
Accent: Acadian	-13.479^{***}
	(0.955)
Accent: African	-11.766^{***}
	(0.852)
Accent: English	-7.404^{***}
	(0.904)
Accent: Québec	-0.181
	(0.660)
Race: black * Accent: Acadian	4.606^{***}
	(0.837)
Race: black * Accent: African	-0.053
	(0.837)
Race: black * Accent: English	2.585^{***}
	(0.837)
Race: black * Accent: Québec	2.096^{**}
	(0.837)
Observations	940
Log Likelihood	$-2{,}945.448$
Akaike Inf. Crit.	5,942.897
Bayesian Inf. Crit.	6,068.890
Note:	*p<0.1; **p<0.05; ***p<0.01

TABLE 7. Results of LME Model

For the convenience of constructing a linguistic hierarchy, the simple effects in our categorical by categorical interaction are derived in Table 8. These are the predicted values of evaluation score of for all combinations of accent and race. For example, white speakers with European accent have an mean estimated evaluation score of 45.7 units (the evaluation score of a combination in this study is defined to be the sum of scores a participant gave to all questions), whereas black speakers with Québec accent have an average evaluation score of 48.8.

Accent	Race	Marginal Mean	SE
European	white	45.7	0.720
Acadian	white	33.6	0.783
African	white	35.4	0.817
English	white	39.7	0.746
Québec	white	46.9	0.672
European	black	46.9	0.720
Acadian	black	38.0	0.783
African	black	35.1	0.817
English	black	42.1	0.746
Québec	black	48.8	0.672

TABLE 8. Marginal Means for Each Combination of Race and Accent

3.2. **GEE Model.** The generalized estimating equation (GEE) model is an alternative model to analyze the longitudinal data, which does not require distributional assumptions. Compared to the LME model, a GEE model does not allow for individual-specific inference in absence of random effects. Instead, it models the average response as an extension of generalized linear models (GLM) to longitudinal data. Therefore, it is a particularly useful tool when examining longitudinal data as GEE models take the correlation between data points into consideration. Since the GEE estimates are consistent even if the variance-covariance matrix is misspecified, the GEE models in the following modeling analysis will always adopt an exchangeable covariance structure. The results of the GEE model are presented in Table 9. Overall, the results from two models are consistent, which confirm the accuracy of the previous model.

Estimate	Estimate	SE	P-value
(Intercept)	47.128	0.666	<2e-16
Race: black	-0.213	0.629	0.73509
Accent: Acadian	-13.479	0.928	<2e-16
Accent: African	-11.766	0.797	<2e-16
Accent: English	-7.404	0.864	<2e-16
Accent: Québec	-0.181	0.673	0.78824
Race: black * Accent: Acadian	4.606	0.953	1.3e-06
Race: black * Accent: African	-0.053	0.837	0.94931
Race: black * Accent: English	2.585	0.923	0.00512
Race: black * Accent: Québec	2.096	0.881	0.01735

TABLE 9. Results of GEE Model

4. **Conclusion and Limitations**

Based on the results from the exploratory analysis, in general, participants held more positive towards European accent and Québec accent than African accent, Acadian accent, and English accent in terms of general perspective, solitary dimensions, status traits, and understandability. There is no statistically significant difference between Québec accent and European accent in these classified evaluations. After integrating the effect of race, the two-way repeated measures ANOVA reveals that the effect of speakers' accents on participants' language attitudes significantly interact with speakers' races.

In the confirmatory analysis, for race, the estimated marginal mean score of black speakers is higher than that of white speakers in each accent except for the African accent. For accent, the

estimated marginal mean scores of Québec accent and European accent are greater than those of Acadian accent, English accent, and African accent. For our particular interest in the comparison between Québec accent and European accent, it is revealed in Table 7 and 8 that the race black effect (black – white) in the Québec accent versus the race black effect in the group of European accent is significantly positive, which is also the Québec accent effect (Québec – European) for black speakers versus the Québec accent effect for white speakers. It means that participants hold more positive attitudes to Québec accents spoken by speakers of either race. However, a greater difference is presented in the group of black group. Or equivalently, no matter what accent it is, black speakers tend to receive more positive feedback, while the difference between black speakers and white speakers with Québec accent will be significantly bigger than those who are with European accent.

There exists some limitations regarding the analyses. Firstly, the original Likert scale was transformed into a continuous variable by taking the sum in this analysis, which is legit because ordinal variables with five or more categories can often be used as continuous without any harm to the analysis. In spite of no harm, it is possible to impose unexpected deviation from the fact on the analysis results. Factor analysis or principal component analysis could be considered to be complementary measures. Secondly, the sample may be too small for a generalized conclusion. It would be better to collect as many and diverse samples as possible in the future. Thirdly, some potential confounders such as age, gender, and linguistic backgrounds were not considered in the confirmatory analysis. Future work should examine these variables in detail.

Appendix A. Figures

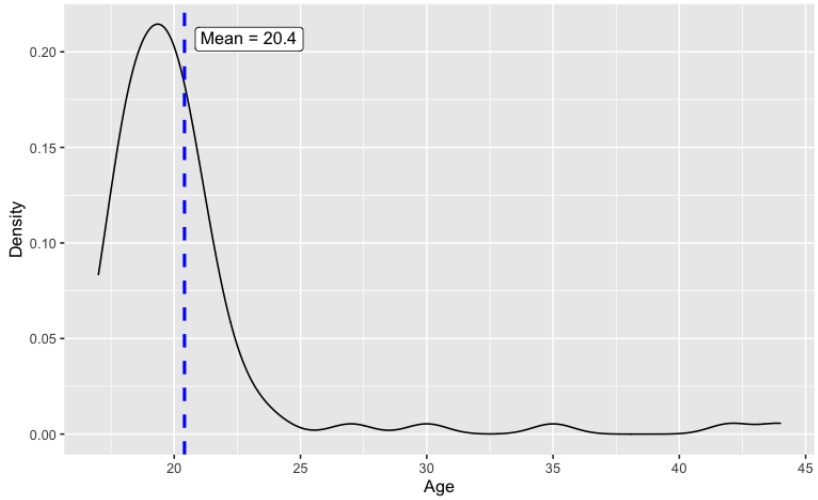


Figure A.2. Distribution of Age

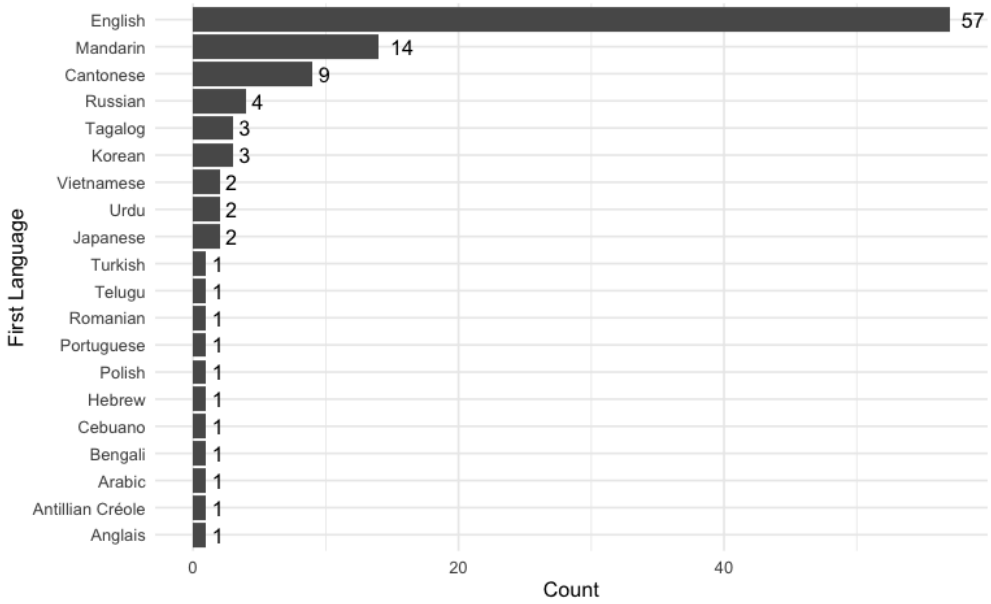
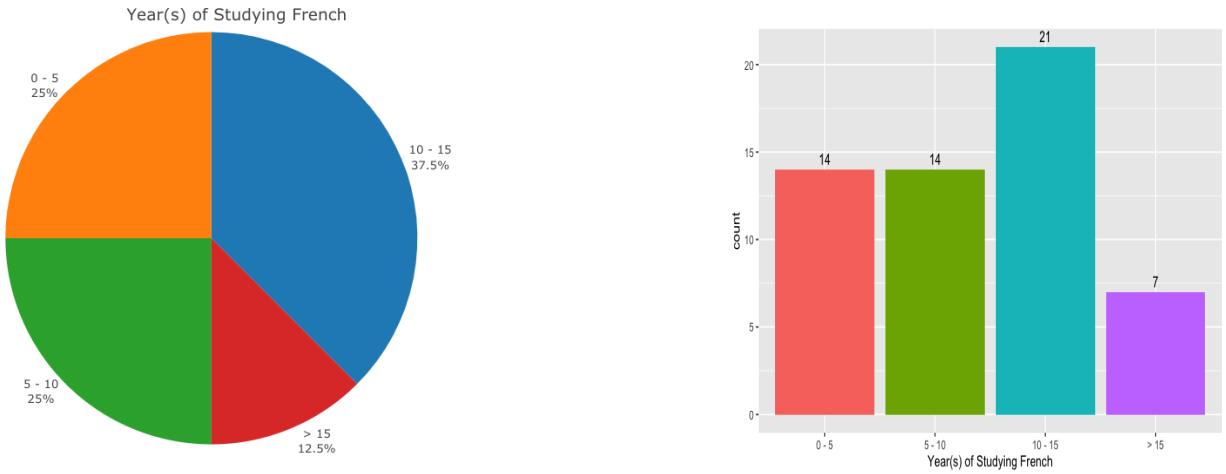


Figure A.3. Distribution of First Language



(A) a (B) b

FIGURE A.4. Year(s) of Learning French

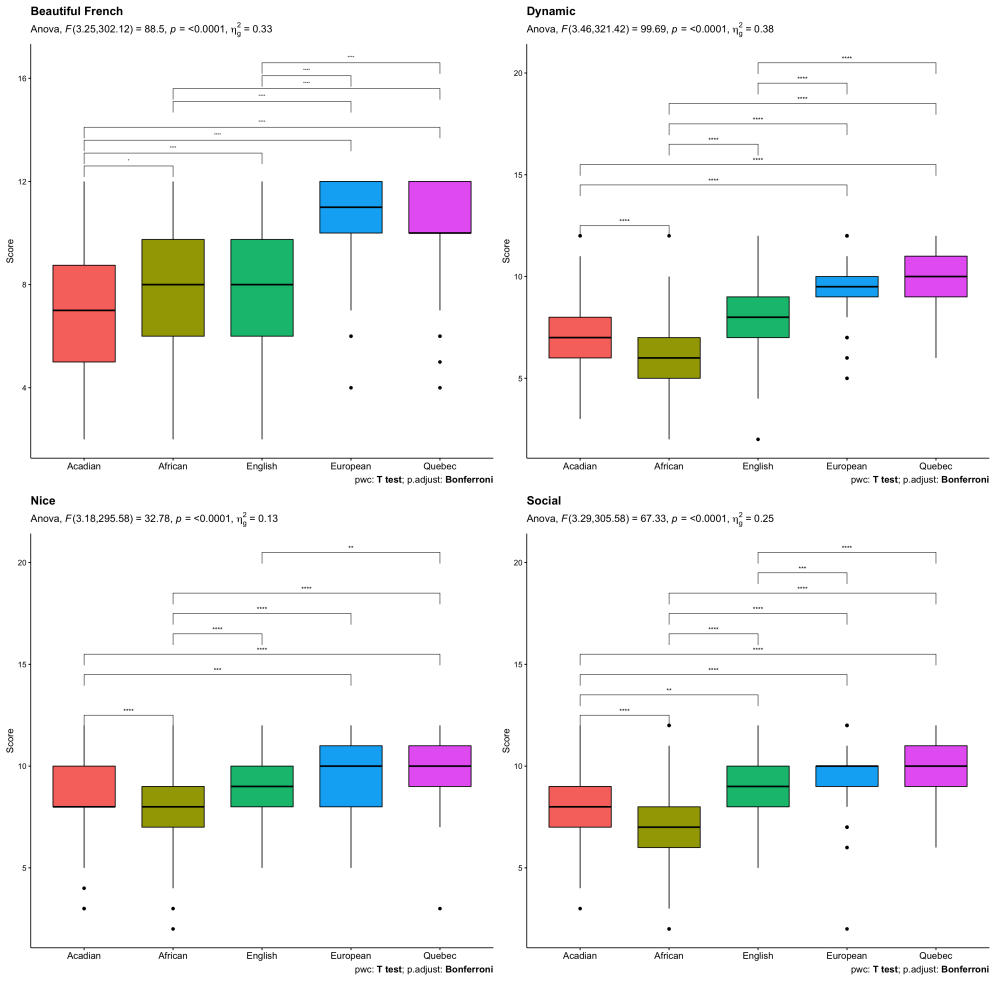


FIGURE A.5. Repeat Measures ANOVA for General Perspective and Solidarity Dimension

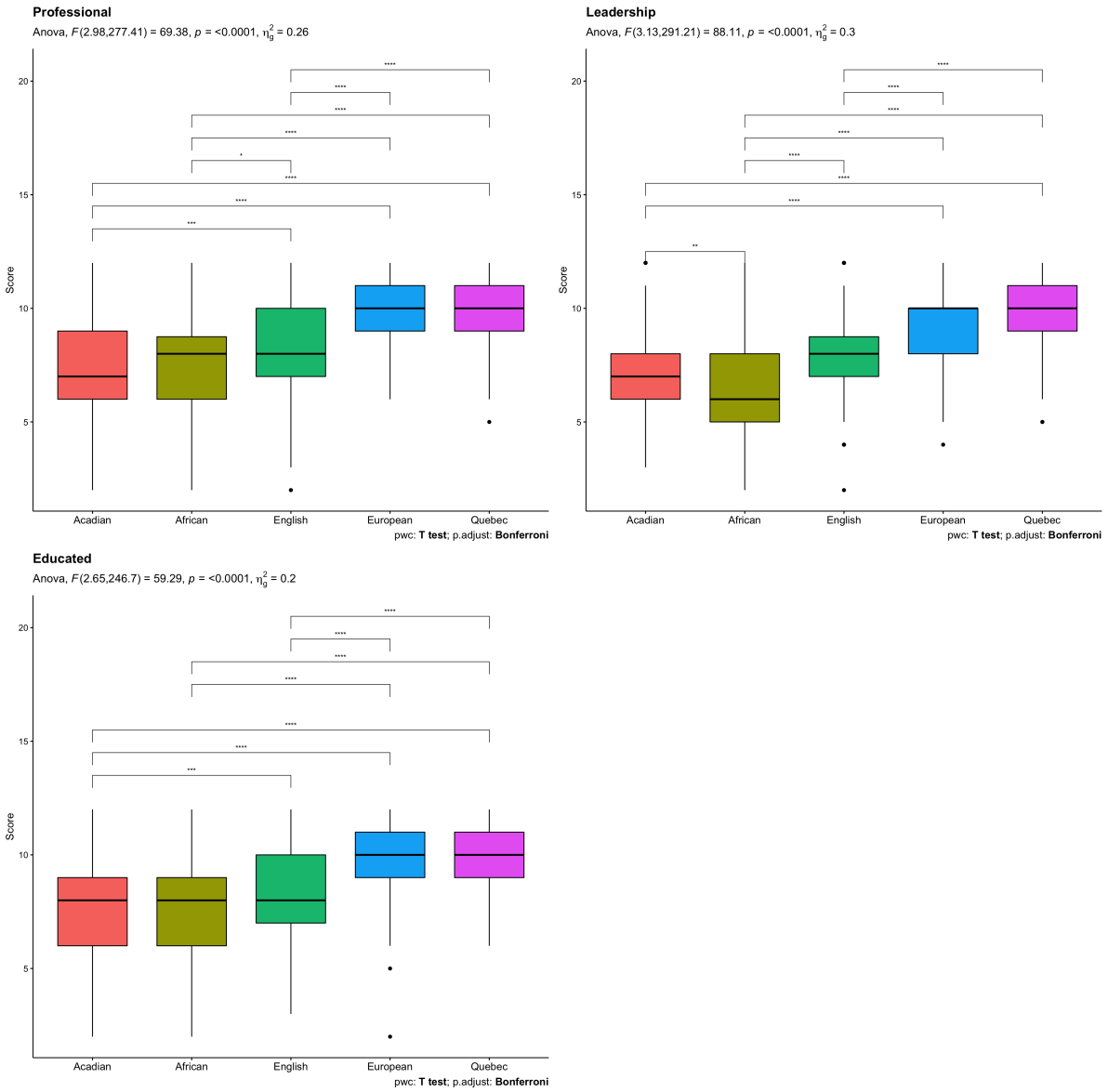


FIGURE A.6. Repeat Measures ANOVA for Solidarity Traits

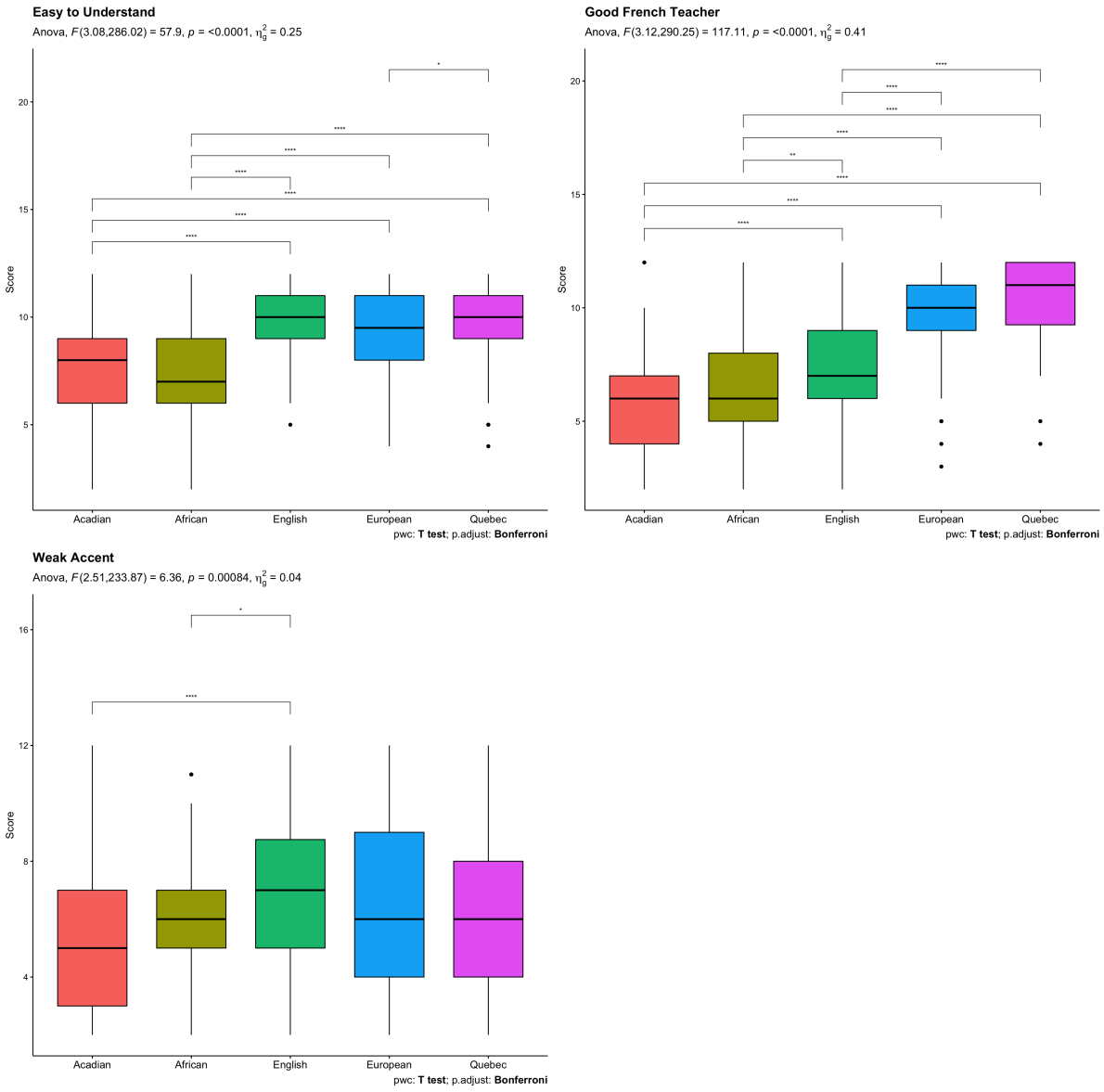


FIGURE A.7. Repeat Measures ANOVA for Understandability

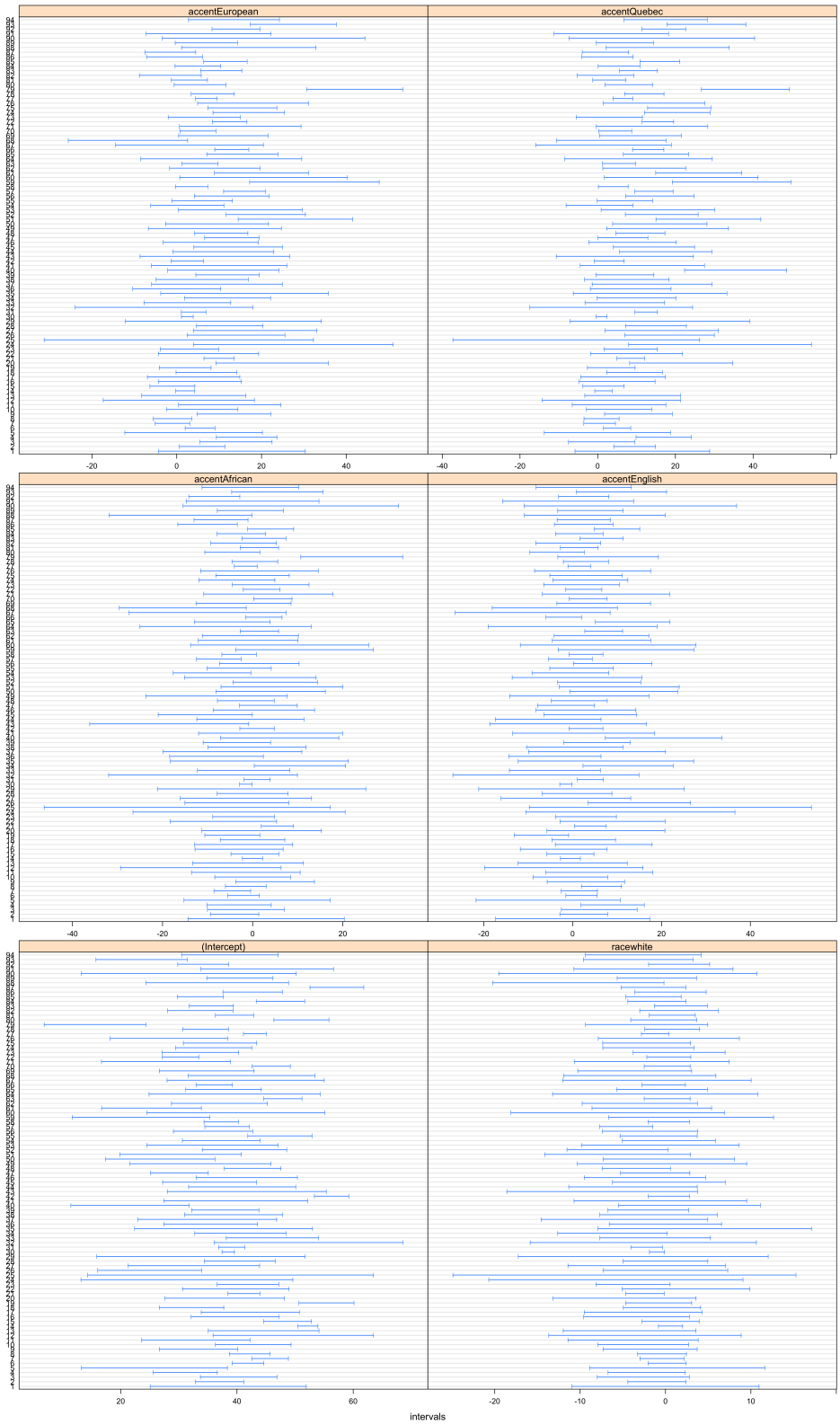
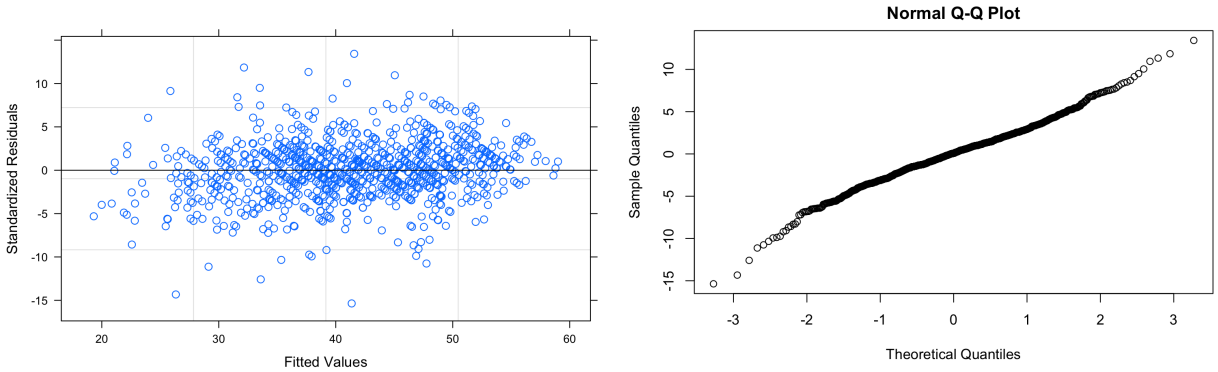


FIGURE A.8. Individual Linear Regression Fits



(A) (B)

FIGURE A.9. Left: Residual vs. Fitted Value of the LME Model; Right: QQ Plot for Residuals of the LME Model