Bilingualism is not a categorical variable: Interaction between language proficiency and usage

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Abstract

Bilingual experience is dynamic and poses a challenge for researchers to develop instruments that capture its relevant dimensions. The present study examined responses from a questionnaire administered to 110 heterogeneous bilingual young adults. These questions concern participants' language use, acquisition history and self-reported proficiency. The questionnaire responses and performances on standardized English proficiency measures were analyzed using factor analysis. In order to retain a realistic representation of bilingual experience, the factors were allowed to correlate with each other in the analysis. Two correlating factors were extracted, representing daily bilingual usage and English proficiency. These two factors were also related to self-rated proficiency in English and non-English language. Results were interpreted as supporting the notion that bilingual experience is composed of multiple related dimensions that will need to be considered in assessments of the consequences of bilingualism.

Accumulating research in the last decade has demonstrated reliable positive cognitive outcomes for bilingualism (Adesope, Lavin, Thompson & Ungerleider, 2010 for meta-analysis with children, Hilchey & Klein, 2011 for a review with adults). The majority of these studies used a between-subjects design to compare performance of bilinguals to demographically-matched monolingual peers. Although such designs can establish fundamental group difference in performance, they are largely insensitive to variability within each group. However, bilingualism is not a categorical variable: The criteria that determine an individual's designation as monolingual or bilingual are fuzzy at best and minimally involve an interaction of language proficiency and usage (Bialystok & Hakuta, 1994; Hakuta, Bialystok & Wiley, 2003; Fishman & Cooper, 1969). In some cases, the "monolinguals" in these studies reported knowing more than one language but their self-rated proficiency in this other language was significantly lower than that of the bilingual group (Gollan, Montoya, & Werner, 2002). It is obviously challenging to find groups of participants who match on all demographic variables and differ only in their language experience because language experience itself is correlated with other factors. It is also difficult to quantify a life experience such as bilingualism. Yet research requires making these judgments, however ambiguous the criteria: Participants in previous studies likely differed in the dimensions that define bilingualism but at present there is no way of determining how to treat those dimensions and how they might affect outcomes. The purpose of the present study is to begin the process of quantifying bilingualism by evaluating the relation between incremental levels of language proficiency and usage in bilingual profiles.

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Research on the cognitive consequences of bilingualism generally shows poorer performance for bilinguals than monolinguals on verbal tasks, such as smaller receptive vocabulary in both children (Bialystok, Luk, Peets & Yang, 2010) and adults (Bialystok & Luk, 2011; Portocarrero, Burright & Donovick, 2007), slower or more effortful lexical retrieval (Liu, Hu, Guo & Peng, 2010; Costa, Roelstraete & Hartsuiker, 2006) even when testing is conducted in the bilinguals' dominant language (Ivanova & Costa, 2008) but superior performance in nonverbal executive control tasks, such as Simon task (Bialystok et al., 2004), flanker task (Costa et al., 2008), or Stroop task (Bialystok, Craik & Luk, 2008). All of these studies were based on comparisons between groups designated as monolingual or bilingual, an approach that is informative in establishing a *difference* between populations with distinct language experience. However, in order to provide an explanation for the divergent behavioral consequences on language and nonverbal tasks, specific experiential *correlates* of bilingualism are necessary to determine their associations with the opposing consequences in nonverbal and language tasks. Therefore, instead of classifying participants as monolingual or bilingual, the present study examined a large sample of heterogeneous bilinguals to determine individual variation in aspects of bilingual experience. This approach assumes that bilingualism is best described as a multi-dimensional construct rather than a categorical variable. Establishing a reliable quantitative basis for bilingual experience will form the basis of investigations of the relation between these quantitative descriptions and verbal and nonverbal outcome tasks. The present study reports only the attempt to quantify bilingualism using multi-factor statistical analysis.

Given the enormous individual variation in bilingual experience, surprisingly little research has attempted to quantify the relevant dimensions of that experience for bilinguals. Using factor analysis and multiple regression analysis, Fishman and Cooper (1969) showed that self-reported language proficiency and usage were the best predictors for four linguistic ratings of bilingualism in a group of 48 Puerto Rican residents in New York. Another potential factor relevant to variation in bilingualism is the length of time that the individual has been bilingual, and recent studies have confirmed the relation between this factor and cognitive outcomes for both children (Bialystok & Barac, 2012) and young adults (Luk, de Sa & Bialystok, 2011). The present study extended this research by validating an approach for assessing language proficiency and bilingual usage.

The assessment in the present study was based on both formal tests of English proficiency and a self-report questionnaire. Questionnaires are commonly used in bilingual research, and participants are frequently asked to indicate self-rated judgments of both their frequency of usage for each language and levels of proficiency (e.g., Elston-Güttler, Paulmann & Kotz, 2005; Gollan & Acenas, 2004; Gollan & Silverberg, 2001). To this end, several questionnaires have been produced to elicit details about individual bilingual experiences. Li, Sepanski and Zhao (2006) collected information from 41 published questionnaires and devised an online questionnaire incorporating their common questions. These included self-assessment of L1/L2 proficiency, bilingual history (age of L2 acquisition, years of residence in the country where L2 is spoken), and home language environment.

Another instrument developed by Marian, Blumenfeld and Kaushanskaya (2007) is the Language Experience and Proficiency Questionnaire (LEAP-Q). They validated the questionnaire internally on 52 participants (Study 1) and then compared the self-rated proficiency responses to standardized measures of proficiency in 50 English-Spanish bilinguals (Study 2). The LEAP-Q required respondents to report age of acquisition for each language, duration of stay in the current country of residence (United States), extent of language exposure, and self-rated proficiency in each language. Data were analyzed using varimax rotation that resulted in three orthogonal factors that they labeled L1 competence, late L2 learning, and L2 competence. These factors may not be completely orthogonal:

Previous research has demonstrated that late L2 learning and L2 competence are related (Mechelli et al., 2004; Perani, Abutalebi, Paulesu et al., 2003). In light of our assumption of the multidimensional nature of bilingualism, it is necessary to consider how specific bilingual experiences also correlate with each other.

The main criterion for inclusion in the bilingual group in most studies is the proficiency level in each of the languages (e.g., Bedore, Pena, Joyner & Macken, 2011; Blumenfeld & Marian, 2007; Dixon, Wu & Daraghmeh, 2012; Proverbio, Adorni, & Zani, 2007; Sumiya & Healy, 2008). However, the daily pattern of language use and the extent of the bilingual experience as determined by the age at which the individual began actively using two languages are also important factors that may affect cognitive outcomes. Moreover, unlike the correlation between age of becoming bilingual and L2 proficiency, age may not be correlated with language use patterns (Flege, MacKay, & Piske, 2002). Thus, to assess bilingual usage as fully as possible, both measures of daily usage and onset age of when active bilingualism began need to be considered.

We developed a questionnaire, the Language and Social Background Questionnaire (LSBQ), complemented by standardized measures of language proficiency, to assess these components of bilingualism. We hypothesized that these components could be captured as related constructs in a sample of heterogeneous bilinguals with varying levels of language proficiency and daily bilingual usage. Furthermore, previous research has shown that onset age of active bilingualism (AoAB) is more sensitive than typical measurements of onset age of second-language acquisition as a predictor of linguistic and nonlinguistic task performance (Luk, de Sa & Bialystok, 2011). To this end, we explored the relationships between the different aspects of bilingual experience and onset age of active bilingualism in a large heterogeneous sample of bilingual young adults.

Method

Participants

One hundred and sixty young adults between the ages of 18 and 30 years were recruited and compensated with monetary reimbursement or course credit. In the present analyses, we focused on individuals who had experience using two languages on a daily basis. Therefore, we excluded participants who did not have this experience (n = 43). Five participants' EVT data could not be collected due to technical error. Two participants were confirmed to be multivariate outlier with Mahalanobois distance greater than 3 in the first model construction and were excluded from subsequent analysis. Therefore, the final sample size included in the model construction was 110 participants (92 females, 21 males) with a mean age of 21.0 years (s.d. = 2.1 years), after excluding these ten participants from the initial sample of 120 bilinguals.. These participants were bilingual in that they reported using two languages regularly but varied in how much usage was dedicated to each language, their proficiency in the two languages, and the age at which they began using two languages. The non-English languages spoken by the participants were Arabic (n = 2), Bulgarian (n = 1), Cantonese (n = 25), Farsi (n = 4), French (n = 12), Gujarati (n = 1), Hebrew (n = 6), Hindi (n = 5), Igbo (n = 1), Indonesian (n = 1), Italian (n = 8), Japanese (n = 1), Korean (n = 6), Mandarin (n = 3), Marathi (n = 1), Polish (n = 2), Portuguese (n = 2), Punjabi (n = 4), Russian (n = 6), Sinhala (n = 1), Spanish (n = 2), Swahili (n = 1), Tamil (n = 4), Toisan (n = 1), Turkish (n = 1), Twi (n = 1), Ukrainian (n = 1), Urdu (n = 5), and Vietnamese (n = 2). All testing was conducted in English and procedures were approved by the university Research Ethics board.

Instruments

Language and Social Background Questionnaire (LSBQ)—The LSBQ contains two sections: (1) demographic and language background (Questions 1–19 in Appendix A) and (2) daily usage of languages and self-rated proficiency (Questions 20–23 in Appendix A). Trained experimenters presented the questionnaire while in discussion with the participant and the experimenter entered the responses to avoid misinterpretation of the questions. On average, it took about 10 minutes to complete the questionnaire. The LSBQ was administered on paper in the present study and was entered into a database after each testing session[1].

The demographic questions (Questions 1–19 in Appendix A) included age, years of education, place of birth, age of arrival in Canada (if not born in Canada), and languages spoken on a daily basis. First language, or L1, was interpreted as native language or the language to which participants were first exposed at home. L1 may not be the same as the dominant language if education was conducted in English even though English was not the home language. Participants were also asked about their history of L2 learning, including the ages for various landmarks in L2 learning and use. These questions were chosen to capture the demographic information, language usage pattern and language acquisition history of participants with diverse language experience. All participants with some bilingual experience were included in the sample to maximize the heterogeneity of language experiences. For participants who only had English-speaking experience, only basic demographic information was obtained.

The next section (Questions 20–23 in Appendix A) assessed self-rated usage and proficiency in each language. These questions were designed to determine how participants managed two languages on a daily basis. For balance of usage, participants were asked to rate the proportion of use of English and the non-English language on a 10 cm visual analog scale (VAS, see Appendix A). VASs are commonly used to assess level of pain in the medical literature and have been shown to be a simple measurement of ordinal preference (McCarthy, Chang, Pickard et al., 2005; Torrance, Feeny & Furlong, 2001). The left end of the scale indicates no English usage, and the right end indicates all English usage. Judgments were made separately for speaking, listening, reading and writing for home and work/school contexts. A total of eight scales relating to various functional usages for two languages were presented. Measurements in centimeter were recorded, with higher values indicating more English use. In the recent electronic adaptation of the questionnaire, these scales were transformed to percentages. In the present study, almost all participants reported exclusively using English in the work/school context, which is the dominant language in the community, so increased bilingual usage was indicated by increased use of non-English languages in the home. To facilitate the interpretation of the scales, the recorded measurements were subtracted from 10 (total length of the VAS) so that higher values indicated more bilingual usage. Finally, the third section used VAS to ask participants to rate their proficiency for each language relative to native speakers on eight scales. Self-rated language proficiency was assessed for speaking, listening, reading and writing in each language. VAS responses in sections (2) and (3) were measured to one decimal place and recorded as interval variables.

Peabody Picture Vocabulary Task-III, Form A (PPVT-III, Dunn & Dunn, 1997)—
PPVT-III was used to measure receptive vocabulary level. The reported median Cronbach's

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[1]A recent version of the LSBQ was designed (please contact coglab@yorku.ca for a copy) and adopted electronically using the Psychology Experiment Building Language (PEBL, http://pebl.sourceforge.net/) so responses were directly entered into an electronic database. The script is available upon request from the corresponding author.

alpha of PPVT-III is .95 (Dunn & Dunn, 1997). A page of four black-and-white line drawings was shown along with a word produced by the experimenter, and participants were asked to choose the picture that best represents the word. Standard procedures for administering the test and determining when to stop testing were followed. Raw scores were transformed to standardized scores using an age-corrected norm table.

Expressive Vocabulary Task (EVT, Williams, 1997)—EVT was used to measure levels of expressive vocabulary in English. The reported median Cronbach's alpha of EVT is .95 (Williams, 1997). EVT is co-normed with PPVT-III. Participants were asked to provide a one-word synonym for a presented picture and a word given by the experimenter. For the purposes of the present study, EVT administration did not include prompting correct responses even though standardized clinical administration allows it. Clinical application of the EVT aims at maximizing the potential performance level of respondents, so prompting is a strategy to elicit correct responses. However, this aim did not apply to this study because participants were from a healthy population of young adults. Furthermore, prompting may bias the goal of objectively assessing expressive vocabulary in English, reducing variance in the data. Nonetheless, standard procedures for establishing basal and ceiling sets and scoring were followed. Calculations of raw and standardized scores were similar to those used for PPVT-III. Age-corrected standardized scores were used in analyses.

Data Analysis

Responses to the LSBQ and standardized scores from PPVT-III and EVT were examined with exploratory factor analysis (EFA), then evaluated with confirmatory factor analysis (CFA). The major reason for using factor analysis (FA) rather than principal components analysis (PCA) is that the question of interest was whether the aspects of bilingual experience being investigated, namely, usage of two languages and proficiency in the community language, differentially predicted the consequences of bilingualism on verbal and nonverbal tasks. PCA provides only linear combinations of variables that maximize variances in the data, but interpretation of the FA results also accommodates the assumption of an underlying causal relationship between the observed variable and the latent construct of interest. Results from the EFA can be found in Appendix B; the final model extracted from the CFA with refined variables is reported in the results section.

We did not include all the questions from the questionnaire in the model to ensure the sample to factor ratio was as efficient as possible (Hatcher, 1994). An efficient model should have at least 100 subjects or five times the number of variables contained in the model. Therefore, demographic and history variables were not included in the factor extraction but were included in subsequent correlation analyses to establish the relationship between quantifiable bilingual experience and the extracted factors. To adhere to the goal of specifying bilingual experiences that relate to verbal and nonverbal task performance, self-reported language proficiency and daily home language usage variables were included in the EFA. Fishman and Cooper (1969) demonstrated that these variables were most representative of highly functional bilinguality. Furthermore, bilingualism does not necessarily imply biliteracy and most participants reported exclusive usage of English at work/school setting (Question 21 in Appendix A). Therefore, only self-rated English and non-English proficiency in speaking and listening (Questions 22 and 23 in Appendix A) and measurements of bilingual usage for speaking and listening (Questions 20a and 20b in Appendix A) at home were included along with PPVT and EVT performance in the factor analysis.

Two model construction criteria were determined a priori to fit the research question: extraction method and rotation method. The extraction method chosen for the EFA was

maximum likelihood (ML) estimation with Heywood adjustment, setting the upper bound of any communality to 1 to avoid the reiterative method converging to have communality greater than 1. ML extraction was used because the analysis provides significance tests allowing the researcher to determine if the number of extracted factors is sufficient to explain covariances between variables. Also, ML extraction estimates factor loadings by maximizing the likelihood of sampling the observed correlation matrix in the population. The number of factors retained was evaluated by four criteria: (1) eigenvalues of extracted factors; (2) scree plot; (3) significance tests from ML extraction; and (4) suitability of factor loadings. In CFA, alpha factoring was used for extraction instead of ML to take advantage of the reliability (or generalizability) of the factors extracted. As with ML extraction, alpha factoring aims to maximize the probability of sampling the observed correlation matrix in a population. The difference is that in ML extraction, the population of sampling correlation matrices is of interest but in alpha factoring, the population of extracted factors is the focus. A major feature of alpha factoring is that it maximizes Cronbach's alpha for the common factors, that is, it maximizes the reliabilities of the extracted factors. The one-eignenvalue criterion, scree plot and factor loadings from an orthogonal rotation were used as evaluating criteria in the CFA. Oblique rotation was chosen in both EFA and CFA to allow correlation between extracted factors, which reflects the interaction of specific bilingual experiences.

Results

Descriptive statistics for the demographic variables included in the EFA are reported in Table 1. Participants reported using a mixture of English and non-English languages for speaking and listening at home (Questions 20a and 20b). Self-reported proficiency was higher for English than the non-English language for both speaking, $t(109) = -5.1$, $p < .0001$, and listening, $t(109) = -4.4$, $p < .0001$. PPVT scores were comparable to those obtained in a previous study from a sample of over 1,600 bilingual young adults (Bialystok & Luk, 2011) and were higher than those found for EVT in the present study, $t(109) = 9.8$, $p < .0001$. However, because the procedures for administering EVT were slightly different from those recommended in the publication manual, the results should be interpreted with caution. Regarding the age of second-language acquisition, 103 participants reported that they had been formally educated in their second language (Question 18b) and 65 reported that they acquired their second language in informal settings (Question 18a), such as at home with their parents or other family members). These reports were not mutually exclusive. Fifty-nine participants reported they acquired their second language in both formal and informal settings while fifty-one of them reports acquiring second language primarily from formal or informal settings. Thus, while most of the bilingual participants acquired their second language formally in a school setting, a significant portion of them acquired their second language both from home and school.

Results from the EFA including self-rated English and non-English proficiency, home language usage in speaking and listening, PPVT and EVT produced a four-factor solution (see Appendix B for details). However, this model did not reach high internal consistency because of the skewness of the self-rated proficiency variables. Several transformations were computed but did not reduce the negative skewness of the distributions. The skewness was a result of large number of participants who rated high proficiency in both English and the non-English language (Ms > 6.9, see Table 1). It should be noted that the correlations between self-ratings of speaking and listening in English were strong with PPVT and EVT, rs > .43, $p < .0001$, despite the skewness of the self-ratings. An exploratory model was conducted to examine whether PPVT and EVT could be substituted by self-ratings of English in speaking and listening. The pattern of results was largely similar to the model reported below, but the skewed distribution of the self-rated proficiency was also reflected in the distribution of the factor scores. Because the aim was to extract factor scores that

would eventually be used to predict performance on verbal and nonverbal tasks, only variables that had normal distributions and were hypothesized to affect the criterion variables were included in CFA. Therefore, all the self-rated proficiency measures were eliminated and a final model was obtained from the CFA using alpha factoring for extraction. This model included four variables: self-reported ratings of home language usage in speaking and listening, and objective proficiency assessments of PPVT-III and EVT.

The one-eigenvalue criterion indicated that two factors should be retained and was confirmed by the scree plot (Figure 1) in which the only break was between factors 2 and 3. Factor loadings of the four variables onto these two factors are shown in Table 2; the two bilingual usage variables load on the first factor and the English vocabulary variables on the second. Thus, these factors are considered to indicate *Bilingual Usage* and *English Vocabulary* respectively. Squared multiple correlations (SMCs) were calculated by treating each factor as a dependent variable and all other variables as predictors in a standardized regression. High SMCs indicate that the factors are well-predicted by the independent variables that load onto that factor. The SMC for English Usage was 0.88 and for English Vocabulary was 0.84, indicating high internal consistency. Estimated communalities (h^2) were high and less than one, indicating that the variables are well-defined by these factors. Finally, the correlation between the two factors was moderate, $r(109) = -.36$, $p < .0001$ (Figure 2).

The two factors represent different aspects of bilingual experience – the extent to which both languages are routinely used and the level of proficiency in at least one of them. English proficiency was of interest because the language of testing was in English and English is the dominant community language for these bilinguals. With the diverse language backgrounds, it was not feasible to assess formal proficiency in the non-English language of the bilinguals. However, self-ratings of the non-English language were highly correlated with bilingual usage (speaking, $r(110) = .45$, $p < .0001$; comprehension, $r(110) = .38$, $p < .0001$) because these self-ratings also reflected self-perceived non-English usage so would not achieve the goal of establishing two related but unique bilingual dimensions. As expected, participants' self-perceived English proficiency also correlated highly with their performance in standard vocabulary measures in English (speaking, $r(110) = 0.51$, $p < .0001$; comprehension, $r(110) = 0.47$, $p < .0001$). English proficiency and bilingual usage were negatively correlated with self-perceived non-English and English oral competence, $rs(110) < -.26$, $ps < .007$, respectively. These negative correlations confirm that there is a reciprocal relationship between the two bilingual dimensions. Therefore, it seemed necessary to maintain the difference between measurement methods for bilingual usage (self-reported) and English proficiency (standardized tests) to capture the distinction between the aspects of bilingual experience in which we were interested.

Previous research has shown that this onset age variable that is based on active usage of the languages is more sensitive than the usual measurements of age at which the second language was acquired for predicting performance on outcome measures (Luk, de Sa & Bialystok, 2011). Onset age of active bilingualism was measured by asking the participant when they began using two languages actively on a daily basis. On the variable AoAB, 18 of the 110 participants reported their onset age of active bilingualism was 0, skewing the distribution and violating the assumption of normality. Therefore, the variable AoAB was transformed with logarithmic base 10, resulting in a sample size of 92 for the correlations. Calculated this way, AoAB was significantly correlated with bilingual usage, $r(92) = .22$, $p < .04$, and English proficiency, $r(92) = -.31$, $p < .003$. These correlations suggest that early onset age of active bilingualism was associated with less balanced daily usage between two languages, higher levels of English proficiency. Furthermore, AoAB was significantly correlated with bilingual participants' self-rated English proficiency in speaking, $r(92) =$

−0.37, $p < .0002$, and comprehension, $t(92) = −0.40$, $p < .0001$, indicating that the younger the participant became actively bilingual, the higher was self-rated English proficiency. In contrast, AoAB was positively correlated with self-rated proficiency in speaking the non-English language, $t(92) = .21$, $p < .05$, but did not correlate with non-English comprehension, $t(92) < .10$, *ns*. These correlations were in the expected directions and provide support for the self-rated proficiency measures.

Discussion

To explore the relationship between bilingual experience and cognition, previous research has sought to establish performance *differences* between monolinguals and bilinguals. A more complete approach to this research would be to examine performance in terms of some of the constituent dimensions of bilingual experience. The present study approached this issue by attempting to quantify the distinct but overlapping dimensions of bilingual experiences. There were two main findings. First, bilingual experience was best described by a multi-factor solution in the analysis of the questionnaire and standardized tests, indicating that bilingualism is not a categorical variable. Second, the factors English proficiency and bilingual usage were significantly correlated with self-rated proficiency in two languages, confirming the validity of self-judgments and the benefit of adopting both standardized and self-rated judgments. We consider each of these findings in turn.

In both the exploratory (see Appendix B) and confirmatory factor analyses, bilingual experience was best represented through multiple factors in the statistical model. In a heterogeneous bilingual sample consisting of individuals speaking a wide variety of non-English languages, bilingual experience was shown to involve at least two dimensions: bilingual usage on a daily basis, and language proficiency in one of the two languages. These two factors separately showed significant correlations with the onset age of active bilingualism. Therefore, this sample possessed sufficient variability in each of these dimensions to capture the history, intensity and performance of bilingual experience. These findings echo Fishman and Cooper's (1969) report suggesting that bilingual experience is best represented by multi-dimensional measurements in a sample of Puerto Rican immigrants in New York, even though the present study was conducted in Canada roughly 40 years later. Bilingual history, measured as onset age of second-language acquisition, has been shown to be associated with subsequent language performance (Birdsong, 2005) and has received more attention than bilingual usage and language proficiency. Indeed, simultaneous bilinguals (exposed to two languages from birth) and early sequential bilinguals have shown different levels of behavioral performance in a lexical representation task (Sebastián-Gallés, Echeverría & Bosch, 2005). However, when examining cognitive consequence of bilingual experience, the onset age of active bilingualism played a more critical role than age of second-language acquisition (Luk, de Sa & Bialystok, 2011).

Bilingualism does not necessarily imply biliteracy, which can be assessed by the reading and writing scales in the LSBQ. Whether reading and writing also contribute to cognition is beyond the scope of this paper. Therefore, the definition of bilingual usage in the present study was restricted to oral language experience and competence. As expected, bilingual usage correlated moderately ($r = −.36$) with English proficiency as reflected in the oblique rotation in the statistical model. This implies that increased bilingual usage is associated with lower English proficiency. When a bilingual devotes more time to using a non-English language, it is not surprising that English attainment is somewhat lower than those who reported a high usage of English. However, this correlation is only moderate, so language usage does not capture all the variance in language proficiency as measured in vocabulary.

The problem of how to adequately assess language proficiency in bilinguals is a pervasive question in studies of bilingual performance. In the present study, the assessment was obtained through both self-assessment and standardized measures. While standardized measurements are objective, self-assessments provide more holistic, although subjective, judgments of proficiency. Therefore, our view is that a composite of self-rated English proficiency in listening and speaking in conjunction with objective testing is more informative than either method alone. One way to examine the validity of self-ratings is to correlate these measures with respondents' formal language proficiency as measured in standardized tests. Even though the solution from the exploratory factor analysis (see Appendix B) did not reach high internal consistency, the correlation between self-rated proficiency in English and performance in PPVT and EVT was significant and strong ($r \sim .50$), providing some support for the reliability of self-rated proficiency measures.

In the present study, we focused on the balanced usage of two languages rather than their order of acquisition. Although there is no language dominance question in the LSBQ, current questions concerning language usage and language proficiency measures have been reported to be associated with language dominance in bilingual children (Bedore et al., 2012) and adults (Gollan, Weissberger, Runnqvist, Montoya & Cera, 2012). Future studies may extend this finding to explore the role of language dominance in bilingual cognition, particularly in the type of sociolinguistic landscape that determines language dominance and in turn influences bilingual usage and language proficiency.

Onset age of active bilingualism was significantly correlated with both English proficiency and bilingual usage but in opposite directions: Earlier onset age of active bilingualism is related to less bilingual usage and higher English proficiency. Given the majority of the participants acquired English as a second language, this observation was not surprising. When included in the factor analysis, onset age of active bilingualism shared significant variance with English proficiency. However, given the number of participants responded age zero as their onset age of active bilingualism, including this variable would decrease the sample size, hence statistical power, in the present analysis. Therefore, onset age of active bilingualism was not included in the factor models, but was correlated with bilingual usage and English proficiency as factors extracted from the statistical models.

The results from the present study provide quantitative measures of aspects of bilingual experience and complement the existing literature by defining bilingualism more operationally. Furthermore, by extending previous research primarily reporting the *differences* in cognition between monolinguals and bilinguals, the present study identifies specific *correlates* of bilingual experiences. Thus, the LSBQ adds to the list of instruments helping bilingual researchers to identify participants with specific experience in regard to their research questions. As in previous studies, data concerning different aspects of bilingual experiences were analyzed in a factor analysis. Building on previous findings and attempting to achieve more ecologically valid measurements, we manipulated the models allowing the factors to be correlated, reflecting a more realistic representation of the dynamic bilingual experiences. Findings from the present study point to the need for more detailed language background information to be reported in studies involving bilinguals, particularly on language proficiency and bilingual usage. A priori classification into bilingual or monolingual groups should outline inclusionary criteria for the bilinguals to inform readers of the sample characteristics.

Our results are consistent with a larger view in which bilingualism is more than simply a language experience. These results showed that at least two aspects of bilingual experience can be extracted from self-reported measures and standardized measures, one concerning the quality of language being used in testing, namely English proficiency, and the other

reflecting the quantity of managing two languages, namely bilingual usage. These dimensions are not mutually exclusive and may be specific to a sample in which English is the primary language of the community and the non-English languages are the dominant language at homes. Future research on bilingual interaction in different contexts and cognitive consequences will shed light on how bilingualism as a life experience shapes our mind and behavior.

Acknowledgments

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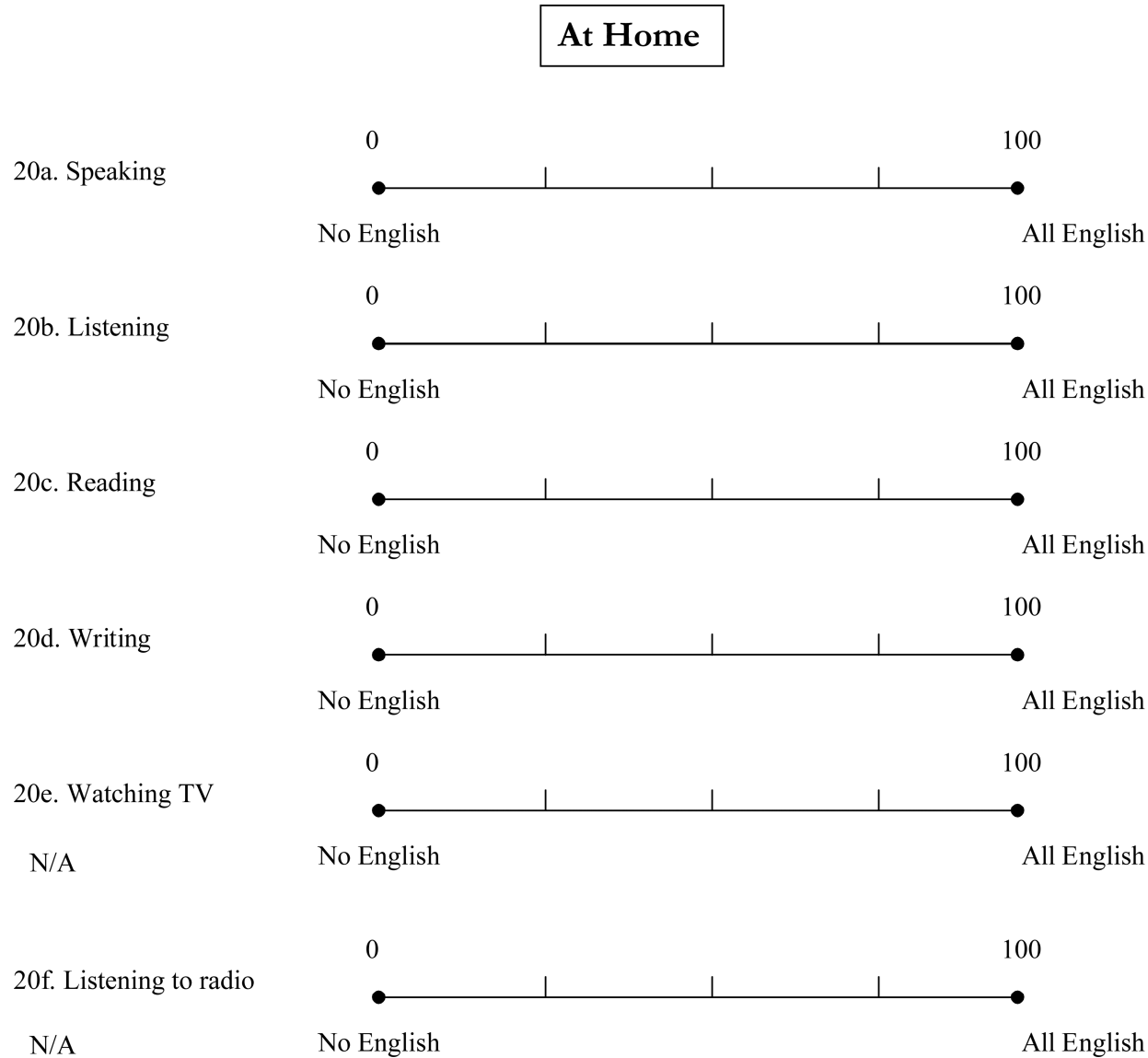
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Appendix A. Language, Social and Background Questionnaire (LSBQ)
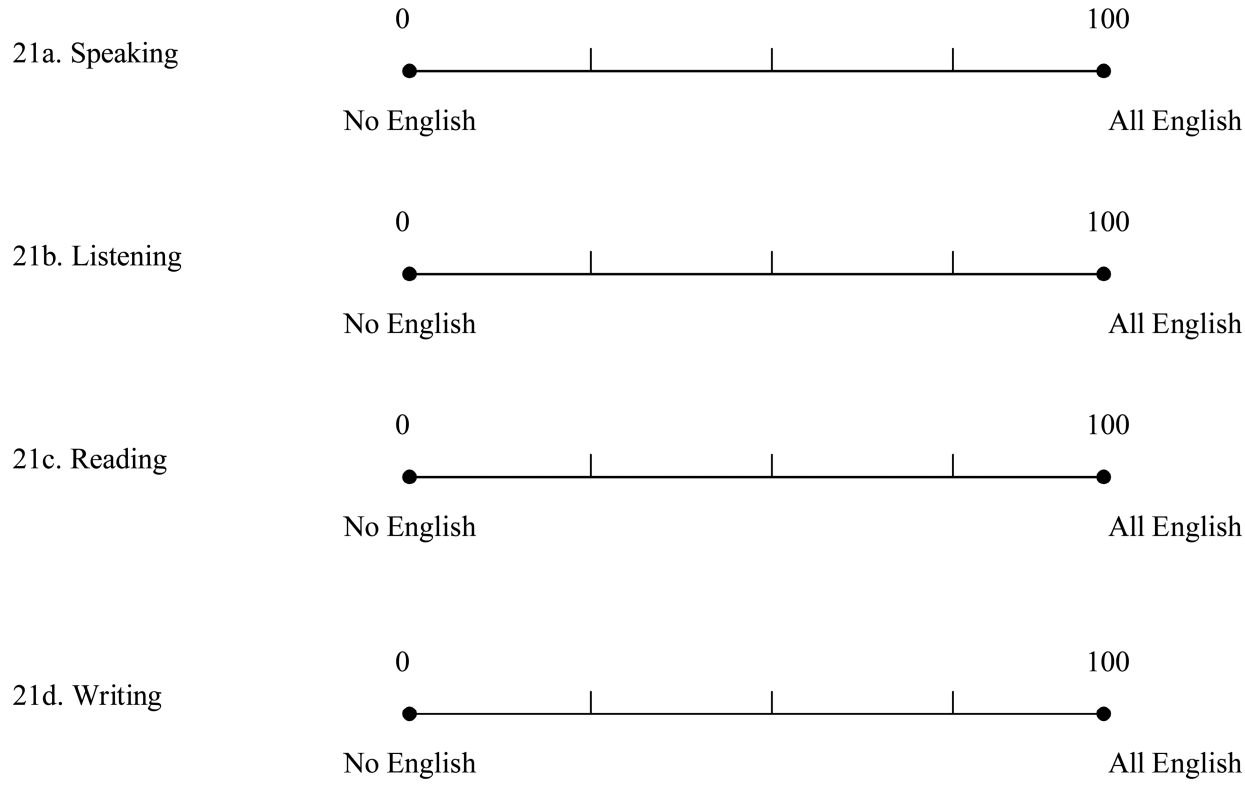
1. Subject ID: _____   2. Today's date:_____

3. Sex: M   F   4. Hand: L   R   5. Date of birth:_____

6. On average, how many hours do you spend on working on a computer every day? _____

7a. Do you play video games?   Yes   No
 b. If yes, how many hours do you play in a week? _____

8. Do you speak any languages in addition to English? If yes, please specify the language(s)

_____

9. Do you need to speak/read/write in the non-English language everyday?   Yes   No

10. Have you ever lived in a place where the non-English language is the dominant communicating
language?   Yes   No

11. If yes, where and for how long? _____

12. Were you born in Canada?   Yes   No   (If yes, skip Q. 13)

13a. If No, where were you born?   _____

   b. when did you first move to Canada? _____

14. What is the first language that you have acquired? _____

15. What is the second language that you have acquired? _____

16. What is your dominant language for the last 5 years?_____

17a. Do you speak any other language(s)?   Yes   No

   b. If yes, what are the language(s)?_____

18. Where did you learn your second language?   Home   School   Community

19a. At what age did you first start **learning** your second language **informally at home**? _____

19b. At what age did you first start **learning** your second language **formally at school**? _____

19c. At what age did you first start **using** your second language actively?_____ ___

In each of the scales below, indicate the proportion of use for English and your other language in **daily life**. These scales are set up for different activities at home or at school/work. On one end of the scale, you have 100 which indicates that the particular activity in that environment is carried out in ALL ENGLISH. On the other end, you have 0 which indicates that you do not use English at all to carry out the activity.

At Home

20a. Speaking

0   100

No English   All English

20b. Listening

0   100

No English   All English

20c. Reading

0   100

No English   All English

20d. Writing

0   100

No English   All English

20e. Watching TV

N/A

0   100

No English   All English

20f. Listening to radio

N/A

0   100

No English   All English

At School

21a. Speaking

0   100

No English   All English

21b. Listening

0   100

No English   All English

21c. Reading

0   100

No English   All English

21d. Writing

0   100

No English   All English

Relative to a native speaker's performance, rate your proficiency level in a scale of 0 – 100 for the following activities conducted in your first and second language.

Language # 1: _____ (please indicate)

22a. Speaking

0   100

Non-native- like   Native-like

22b. Understanding (Comprehension)

0   100

Non-native- like   Native-like

22c. Reading

0   100

Non-native- like   Native-like

22d. Writing

0   100

Non-native- like   Native-like

Language # 2: _____ (please indicate)

23a. Speaking

0   100

Non-native- like   Native-like

23b. Understanding (Comprehension)

0   100

Non-native- like   Native-like

23c. Reading

0   100

Non-native- like   Native-like

23d. Writing

0   100

Non-native- like   Native-like

Appendix B. Results of exploratory factor analysis

Exploratory factor analysis extracted four factors with eigenvalues greater than one (an eigenvalue greater than one signifies that a factor contributes more than one unit of variance in the data). Hatcher (1994) suggested that only factors with eigenvalues greater than one should be retained in the model. Therefore, based on this criterion, four factors were retained. The second evaluating criterion was the scree plot, a visual representation of the extracted factors' eigenvalues (see Figure B2). The objective was to look for a "break" in the continuum of values, which serves as a basis for identifying the number of meaningful extracted factor(s). The scree plot helps to identify the number of retainable factors in the

analysis. In this case, a "break" between successive data points would indicate the number of factors to be retained.

Figure B1. Scree plot from exploratory factor analysis indicating three "breaks".
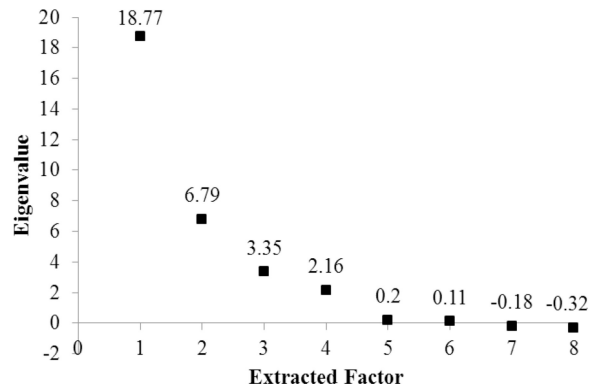
Visual inspection of the scree plot indicates a first break between factors 1 and 2 and a second between factors 4 and 5. With two breaks in the scree plot, the adequate number of factors to extract from the data is indeterminate. The positions of the breaks suggest two possible solutions: one-factor and four-factor. The one-factor solution is inconsistent with the proposed research questions and the theoretical nature of bilingualism, so it was not pursued in subsequent analysis. The four-factor solutions fit the theoretical nature of bilingualism. The eigenvalue of one criterion indicates that four factors should be retained, which is consistent with one of the solutions suggested by the scree plot. Based on the eigenvalue of one criterion and the scree plot, the four-factor models were investigated further.

Significance tests obtained from the ML extraction were used to confirm the adequacy of the four-factor exploratory models and were treated as a confirmatory strategy. Chi-square tests for model fitting were used for this purpose. A significant result indicated that the model with specified number of extracted factors being tested was not sufficient to explain the complete set of data. Therefore, the goal of these tests was to reach an insignificant chi-square test. The first significance test examined if the model structure suggested more than one common factor extracted from the complete dataset and confirmed the hypothesis, χ^2 (28) = 498.4, $p < .0001$. The next tests examined whether a four-factor solution was sufficient to explain the multivariate relationship of the variables, χ^2 (2) = 3.6, *ns*. On this basis, the four-factor solution appeared to be the most appropriate solution to the model.

Factor loadings, estimated communalities, and proportion of variance and covariance from the ML extraction are reported in Table B1. Tabachnik and Fidell (2007) suggested considering only factor loadings greater than 0.45 (20% of variance) as significant. Visual inspection of factor loadings indicated that each variable loaded on only one of the four extracted factors after promax rotation. All four factors extracted had an eigenvalue greater than one. From visual inspection of the pattern matrix reported in Table B1, it was clear that variables measuring self-rated proficiency level of oral English and the non-English language formed factors 1 and2. Variables loading on factors 3 were the visual analog scales measuring how "balanced" oral usage of speaking and listening to English and the other language was in home settings, whereas factor 4 involves the two variables reflecting receptive and expressive English proficiency measured by PPVT-III and EVT.

Table B1

Rotated factor loadings and estimated communalities (h^2), for maximum likelihood extraction and promax rotation on the LSBQ data[a].

Variable	F1[b]	F2	F3	F4	h^2
Bilingual usage in speaking	−.01	.12	**.91**	−.08	1.00[d]
Bilingual usage in listening	−.01	.08	**.85**	.08	0.63
Self-rated level of speaking non-English	−.05	**1.00**	−.03	.05	1.00
Self-rated level of listening non-English	.05	**.74**	.02	−.04	0.56
Self-rated level of speaking English	**.74**	.01	−.05	.15	0.71
Self-rated level of listening English	**1.03**[d]	0	.02	−.04	1.00
Receptive English vocabulary (PPVT-III)	0	−.05	−.02	**.86**	0.77
Expressive English vocabulary (EVT)	.07	.05	.06	**.81**	0.67

[a] Table entries are obtained from rotated factor pattern.

[b] Suggested factor labels: F1 = Self-rated proficiency of non-English; F2 = Self-rated level of oral non-English language;; F3 = Bilingual usage of two languages at home; F4 = Formal English vocabulary level.

[c] bold cell values highlight factor loadings above 0.45.

[d] Factor loadings or estimated communalities equal or exceed 1 because of the oblique rotation; and possible inherent problems with the solution.

The four-factor solution provides a comprehensive account based on the one-eigenvalue criterion, the scree plot, and the significance tests from ML extraction. Its problem, however, is that it does not pass the model efficiency and internal consistency criteria. First, as reported in Table B1, a few a priori estimated communalities are greater than or equal to one. Communality estimates indicate, for each variable, the estimated proportion of variance shared with a common factor. Estimates greater than or equal to one suggest problems, such as too little data and/or too many factors extracted. Although these communality estimates contradict ML extraction significance tests, they were interpreted as cautionary because they indicated that the model's internal consistency was not achieved. The problems were possibly caused by the non-normality of the self-rated proficiency variables. Second, the significant correlations between factors (see Table B2) indicate complex factor structures that reflect intercorrelations between factors, confirming the expectation that bilingual experiences were correlated, with the self-rated proficiency variable highly correlated with other factors. The goal of this factor analysis was to generate factor scores for bilingual subgroup comparisons; therefore, Tabachnik and Fidell's (2007) suggestion of using simple factor structures for ease of interpretation was adopted. The self-reported proficiency variables were eliminated because of their skewed distributions and high correlations with other factors.

Table B2

Correlations between factors extracted from the four-factor solution.

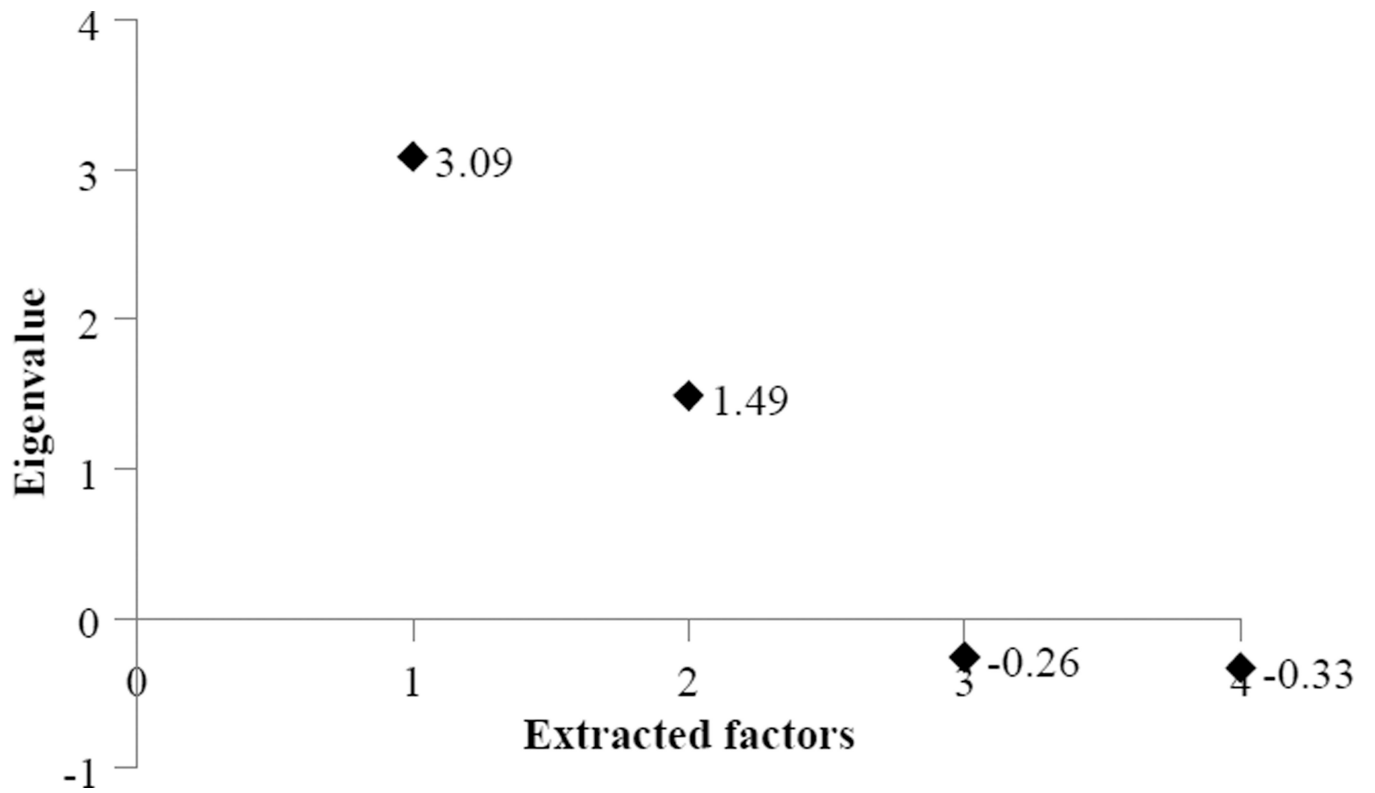| Factor	F1	F2	F3	F4
F1: Self-rated proficiency of oral English	--	−.33[**]	−.34[**]	.56[**]
F2: Self-rated level of oral non-English language		--	.46[**]	−.29[*]
F3: Bilingual usage of two languages			--	−.37[**]
F4: Formal English vocabulary level				--

*
 $p < .01$

**
 $p < .001$

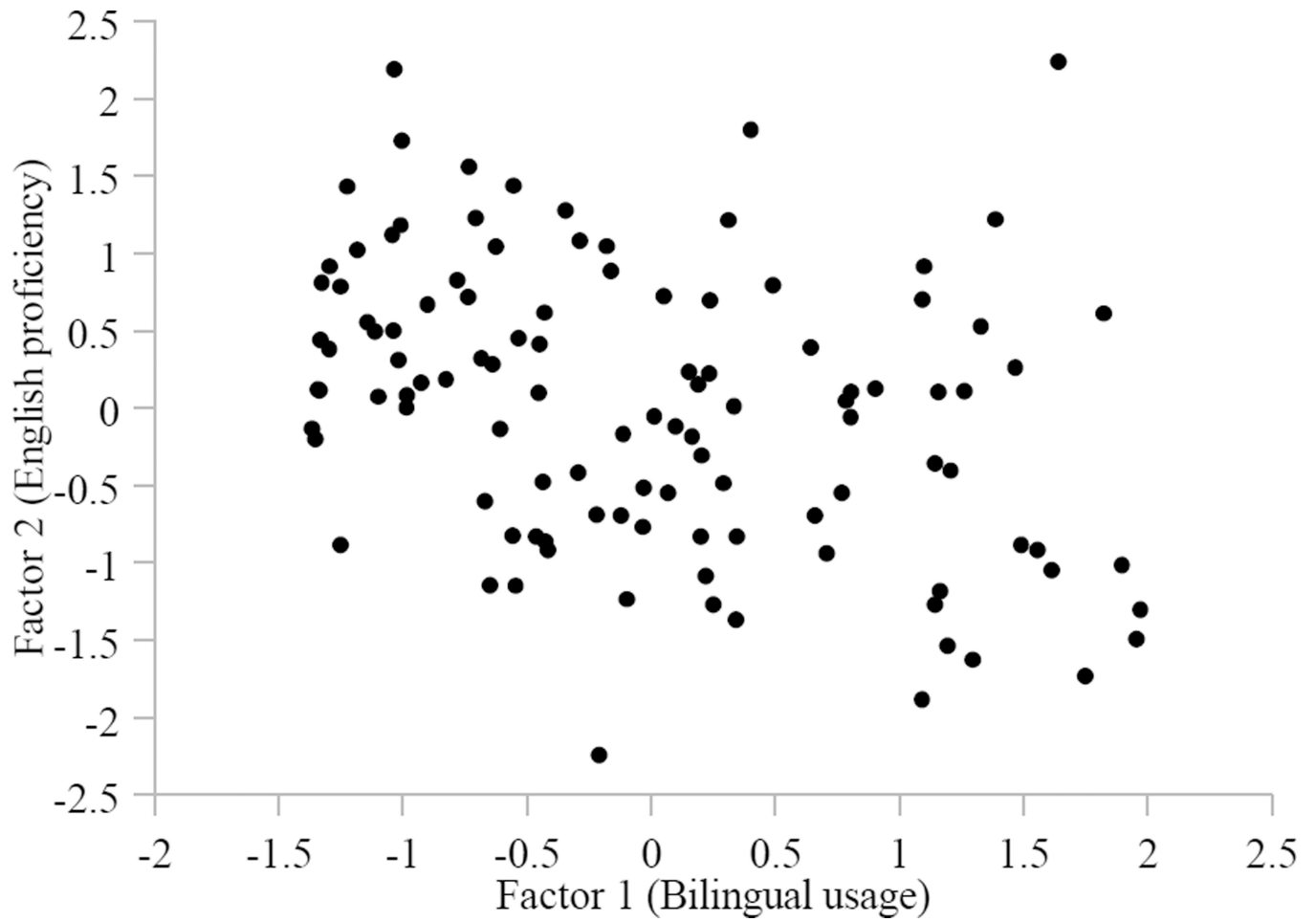**Figure 1.**
Scree plot for the CFA.

Figure 2.
Scatterplot of factor scores for Bilingual usage and English proficiency from confirmatory factor analysis.

Table 1

Descriptive statistics for all participants

Variable	Mean	S.D.	95% Confidence Limits of the mean
Variables included in the EFA			
Bilingual usage in speaking at home[a]	4.0	3.1	(3.5, 4.6)
Bilingual usage in listening at home[a]	4.3	3.0	(3.7, 4.8)
Self-rated speaking ability in non-English[a]	6.9	2.7	(6.4, 7.4)
Self-rated listening ability in non-English[a]	7.8	2.3	(7.3, 8.2)
Self-rated speaking ability in English[a]	8.5	2.0	(8.2, 9.0)
Self-rated listening ability in English[a]	8.9	1.6	(8.7, 9.2)
PPVT standard score ($\mu = 100$, $= 15$)	96.9	12.5	(94.6, 99.3)
EVT standard score ($\mu = 100$, $= 15$)	86.8	15.9	(83.8, 89.8)
Bilingual history variables			
Onset age of L2 acquisition in formal settings	7.1	3.4	(6.4, 7.7)
Onset age of L2 acquisition in informal settings	3.5	3.9	(2.5, 4.5)
Onset age of active bilingualism	9.9	6.0	(8.7, 11.0)

[a]Maximum value possible is 10.

Table 2

Rotated factor loadings and estimated communalities (h^2) for alpha factoring extraction and promax rotation. Bold cell values highlight factor loadings above 0.45.

Variable	Bilingual usage	English proficiency	h^2
Home usage of speaking English	**.86**	−.14	.84
Home usage of listening to English	**.89**	.12	.74
Receptive English vocabulary (PPVT-III)	−.06	**.86**	.77
Expressive English vocabulary (EVT)	.06	**.85**	.70