Arizona Working Papers in SLA & Teaching, 22, 62-82 (2015)

BILINGUAL DECISION MAKING: A VERBAL PROBABILITY STUDY

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Do second languages speakers (L2) of any language make decisions that are measurably different from first language speakers (L1)? One way to explore this question is through the expression of probability. Probability can be expressed numerically ("75%") or verbally ("probable") and both numerical and verbal probability expressions have been studied extensively in medical, legal, and management contexts. In terms of utilization, verbal probability expressions are preferred more than numerical probability expressions despite their lack of precision because of their ease of use (Kuipers, Moskowitz, Kassirer, 1988), their ability to express a wider range of possibilities (Zwick, 1987), and the fact that using verbal probabilities rather than numerical probabilities costs decision-makers very little in terms of accuracy (Hamm, 1991a; Wallsten, Budescu, & Erev, 1988). Decision making research to date, however, has assumed that participants in these studies speak the same language(s). Using verbal probabilities to investigate possible decision-making variability between L1 vs. L2 speakers is a way to explore: 1) If there are differences in decision making between L1 and L2 speakers: 2) If there are differences, are they significant: 3) If there are differences, do native speakers assign higher or lower probabilities than non-native speakers for the same event? In this study, findings from 180 L1 and L2 subjects are reported. Subjects were provided the same verbal probability expressions (VPEs) and asked to assign numbers to ten VPEs – "rare," "very unlikely," "unlikely," "likely," "possible," "probable," "good chance," "frequent," "usually," and "very probable" (Theil, 2002). Within subject and between subject tests were conducted and results show dissimilarities between L1 and L2 speakers' numerical valuations.

Keywords: *bilingual, second language, decision making, verbal probabilities*

INTRODUCTION

Judgment and Decision Making (JDM) is the interdisciplinary study of human judgments and decision making that draws from the fields of economics, behavioral economics, psychology, philosophy, law, medicine, public policy, consumer behavior, and business. JDM focuses on issues ranging from experts' decisions, forecasting, and prediction, as well as bargaining and negotiation. Researchers who study JDM evaluate human decisions in terms of heuristics and biases, coherence and correspondence, and improving diagnostic decisions in information-rich environments. Its breadth is impressive. Yet there are few if any studies for how and why decision making potentially varies between first (L1) and second (L2) language speakers.

LITERATURE REVIEW

Within applied linguistics and the closely related field of second language acquisition (SLA) there are approaches for studying how L2 speakers perform differently from L1 speakers. In eye-tracking studies, second language readers typically take longer to read the same information (Duyck et al., 2008; Rayner & Juhasz, 2006; Frenck-Mestre, 2005; Lehtonen, 2012).

Unfamiliar phonology and scripts combined with semantic mapping makes L2 reading a challenge. Longer processing time for L2 speakers may indicate differential processing or decision making that deviates from L1 speakers' decisions. Lexical decision studies examine how L1 and L2 speakers recognize words and non-words. L2 speakers are typically slower to react to words than are L1 speakers (Inhoff & Rayner, 1986; Schilling, Rayner, & Chumbley, 1998; Lété, Zagar, and Pynte, 2007; Libben & Titone, 2009; Paribakht, 2004; Gollan et al., 2011; Frenck-Mestre, 2005; Lehtonen, 2012; Famoyegun et al., 2013; Whitford & Titone, 2012).

Within SLA, the term "interlanguage" refers to the language that is used by L2 speakers that resembles both the language being learned (new vocabulary) and the first language (syntax) of the speaker who is learning a new language (Selinker, 1972; Brown, 1973; Dulay & Burt, 1972-73; Krashen, 1981-82, 1985). It seems reasonable to assume, then, that L2 speakers will not only use a new language differently, but also process some of the same words and linguistic structures unlike L1 speakers, leading to behavioral consequences. For example, L2 English speakers learn the suffixes in the following order: 1) –ing (progressive: I am decid**ing**), 2)–s (plural: decision**s**), 3) 's (possessive: the judge**'s** decision), 4) –ed (past tense marker: She decid**ed** yesterday) (Dulay & Burt, 1972-73). Once learned, L2 speakers then explore ways to use words and structure that sometimes match the target language. In the process of acquiring a language, it would not be surprising to find that decisions that L2 speakers make vary as a function of language competence. This study aims to identify if the fields of JDM and SLA indeed align and interact in the lives of multilinguals and language learners. Applied linguists and SLA researchers study the processes of acquisition, comprehension, and production of a new language. Decision making is the study of normative, descriptive, and prescriptive theories of judgments and decisions. It is not enough to simply understand then describe the acquisition behavior of learners because many second language speakers are in professional work settings making real-world decisions. By applying decision making theories and practices to SLA, key distinctions between L1 and L2 speakers' behaviors can be understood.

In order to begin the process of examining how decision making can vary as a function of language competence, in this study, I take a look at "verbal probabilities" as a line of research that can act as an early test of bilingual decision making.

'Verbal probabilities' is a predominant line of research within JDM that refers to those words and expressions for which there is an assumed number or numerical range. Despite verbal probability "vagueness," VPEs "can be given an approximate location on the probability scale" (Teigen & Brun, 2003, p. 54). An expression such as "very unlikely" would be expected to index to numerical evaluations on the lower end of the 1-100 spectrum while an expression such as "very probable" would be expected to index to numerical evaluations on the higher end of the 1-100 spectrum. Hamm (1991) found that scores depend on the "object whose probability is being discussed" (p. 214). "Very unlikely" ranged from .046 - .186 and "very probable" ranged from .733 -.880. Patt and Schrag (2003) found that undergraduate subjects were more likely to use descriptors implying higher likelihood to describe a hurricane than to describe snow flurries, even when the numerical likelihood of occurrence for both events were the same. A key question is whether L1 and L2 speakers provide ranges for verbal probability expressions that do not overlap or overlap very little.

Context drives L2 speakers as it does L1 speakers, but context may influence L2 speakers in a way that is significantly different from L1 speakers. "Bilingual decision making" may help support or disclaim JDM studies based in a single language. Evidence can strengthen theories or point to the need to modify or change existing JDM theories and Bilingual Decision Making (BDM) offers a framework with which to study language and cognition.

The answers to these questions have important behavioral outcomes. According to a *New York Times* article in 2012, 1 in 4 doctors at in the United States are trained in foreign medical schools (McAllester, 2012). Many of the doctors speak a first language other than English meaning that they could use verbal probability expressions in a distinct manner than their first language counterparts. Do these doctors use language laden with probabilities similarly if they have been trained in the United States? What about doctors from countries whose first language is English such as the United Kingdom, India, or Nigeria? Varying numerical valuations cause miscommunication when L1 speakers use VPEs but the miscommunication potentially becomes more complicated when L2 speakers use the same VPEs in the same linguistic environments.

Investigating bilingual decision making may lead to the discovery of other behavioral approaches to cognition. For example:

- A doctor whose first language is English informs a nurse whose first language is not English that a sick patient likely has strep throat and should *probably* be given an antibiotic.
- A student whose first language is not English reads a professor's instructions whose first language is English that "there will *likely* be a final exam" as a low probability event. The professor who writes the instructions and whose first language assesses *likely* as a high probability event. Both student and professor will be frustrated.

If it can be found that there is a standard deviation difference in how verbal probabilities are valued in the same context, then these results could lead to a better understanding of how L1 and L2 speakers in high-stakes situations communicate. Understanding that a second language speaker may give varying values for a word such as "rare" could help a first language speaker assess the information more accurately or, more practically, it may prompt the first language or second language speaker to ask, " Can you give a number for the word *rare?*" This is not to suggest that professionals whose first language is not English are less qualified as practitioners or accurate in their communication than L1 professionals. The question is rather whether decisions can be explained in language competence.

Related Studies

Language effects on verbal probabilities have been addressed previously, even if indirectly. Framing their study in terms of culture rather than language, Lau and Ranyard (2005) study risk preferences in Chinese and English speakers. They hypothesized that gamblers tend to be "overconfident in gambling and to think less probabilistically toward the outcomes" than non-gamblers (p. 622) irrespective of culture. This suggests an underlying cognitive difference in humans irrespective of language. However, the authors also hypothesized that Chinese would demonstrate "lower levels of probabilistic thinking and would display more risky behavior in horse race gambling decisions involving uncertainty" than their English counterparts participating in the same mock horse race (2005, p. 622). The results confirmed the hypotheses. Lower levels of probabilistic thinking were found in gamblers than non-gamblers and in "Chinese compared to English participants" (p. 623). While Lau and Ranyard's (2005) study indicate differences between two language groups, discussed as cultural groups, the study does not compare how two groups behave with the one language in a similar cultural context.

Budescu, Por, and Broomell, S. B. (2012) assessed numerical counterparts to the verbal descriptions *very likely*, *likely*, *unlikely* and *very unlikely* to examine what impact ideology has on individual differences in responses. Subjects read eight sentences that "contained probabilistic terms pertaining to climate events" (p. 186). The sentences derive from reports by the Intergovernmental Panel on Climate Change (IPCC), a United Nations organization. The results show the mean estimates to be 41 for *very unlikely*, 44 for *unlikely*, 54 for *likely*, and 62 for *very likely*. Budescu et al. conclude (2012) "participants who identify strongly with the Democratic party assigned higher probabilities to all the words than the participants who identify strongly with the Republican party with the participants with weaker, or no, political affiliation" (p. 189). The study by Budescu, Por, and Broomell (2012) indicate that there can be different interpretations of verbal probabilities based on ideology. Building on this work, it would be useful to discover if underlying differences exist between first- and second-language speakers.

Chen (2013) studies if differences in savings rates are related to the way a person's language encodes time. For example, in English one might say *it will rain tomorrow* whereas in German one might say *es regnet Morgen* (*it rains tomorrow*). Chen hypothesizes "that being required to speak in a distinct way about future events leads speakers to take fewer future-oriented actions" (p. 1). If the future is removed from the speaker as in the case of English speakers and it is not removed as in the case of German speakers, then Chen predicts that German speakers would have higher savings rates than English speakers as measured by countries' bank data. The finding supports the hypothesis. The more language encodes time in the present such as German, the higher the savings rate. English speakers save "only 46% as often" as German speakers. The concern with these findings is that they encode social and historical variables. Germany's banking system is more regulated by the state and Germans have a higher per capita income along with lower health care and education costs. One of language's functions, however, is that it encodes cultural values, historical records, and societal norms that influences behavior and as such the studies cited above indicate a connection between first- and second-language and verbal probability expression assessment. There is a difference, but the degree and the direction of difference will have to be informed by the data. These studies that demonstrate correlations do not demonstrate causation.

METHOD

Participants

A total of 180 subjects participated. Thirty-four L1 speakers of English (33 undergraduate students enrolled in an English 101 composition course, ages 18-24, m = 13, f = 21, and one instructor, 41-year old female), along with 146 L2 speakers of English enrolled in an on-campus language institute, ages 17-50, m = 86, f = 60, completed a 4-part, 10-15 minute questionnaire on verbal probability expressions (VPEs). L2 subjects' languages were Arabic (n = 49), Portuguese (n = 50), and Spanish (n = 33), and Chinese Mandarin (n = 11).

Subjects in intermediate and advanced classes were recruited. Basic demographic data were also collected. Answers from two subjects were removed as they wrote “100” in every answer across all conditions.

Materials and Design

Verbal probability expressions were presented in four conditions: 1) VPE in isolation, 2) VPE – random event – numerical range, 3) VPE in context – monthly event – one number, and 4) VPE in context – daily event – one number. Participants were asked to assign one number from 1-100 to 10 VPEs: *rare, very unlikely, unlikely, possible, likely, probable, good chance, frequent, usually*, and very *probable*. The VPEs are based on Theil’s (2002) review of ten verbal probability studies. Mean scores from Theil (2002) are shown in Table 1.

Table 1

Mean ratings for verbal probability expressions

Probability expression	***Cl***	***Ha***	***Ja***	***Ke***	***Ko***	***La***	***Li***	***P1***	***P2***	***Ta***
Rare	14.00	11.90	5.00	5.30	-	-	7.00	-	-	13.81
Very unlikely	-	15.90	10.00	-	-	-	9.00	-	-	28.44
Unlikely	24.00	-	19.00	-	14.00	18.53	18.00	-	-	31.42
Possible	55.00	-	-	-	27.00	33.47	37.00	44.40	47.10	-
Likely	-	-	77.00	-	63.00	67.18	72.00	67.30	69.50	-
Probable	67.00	-	-	-	64.50	65.00	71.00	-	-	74.66
Good chance	71.00	72.30	-	-	-	-	74.00	-	-	82.18
Frequent	74.00	-	78.00	-	56.00	-	-	-	-	81.16
Usually	72.00	-	-	75.90	-	-	77.00	-	-	73.71
Very probable	79.00	83.50	-	-	-	-	87.00	-	-	82.50

Table 1: Reproduction of mean ratings of verbal probability expressions, Theil (2002).

Cl = Clarke et al., 1992; Ha = Hamm, 1991; Ja = Jablonowski, 1994; Ke = Kenney, 1981; Ko = Kong et al., 1986;La = Laswad and Mak, 1997; Li = Lichtenstein and Newman, 1967; P1 = Pellissier and Van Buer, 1996; non-entrepreneurs; P2 = Pellissier and Van Buer, 1996; entrepreneurs; Ta = Tavana et al., 1997.

Subjects received oral and written instructions prior to beginning the survey. The online form included the study’s purpose, estimated time to complete the questionnaire, a consent form, and instructions.

Condition 1. VPE in Isolation – One Number

Procedure. Verbal probability expressions (VPEs) were presented in isolation. Subjects assigned one number to each VPE. This condition is modeled after a study by Clarke et al. (1992) who orally asked interviewees to provide estimates for “60 isolated expressions of probability” (p. 638; See appendix B, page 18, for full instructions).

Condition 1 results. The results in condition (isolation) show no distinct patterns. As a group, the 146 L2 speakers gave higher probabilities than L1 speakers in four out of the 6 VPEs. Likewise, comparing L1 English speakers to L1 speakers of Arabic, Chinese, Portuguese, and Spanish show uneven assessments for the same VPE’s.

Condition 1 discussion. Participants’ scores in the isolation condition will act as a baseline for the other three conditions. Mean L1 and L2 scores are compared against Theil’s (2002) review of ten verbal probability studies (see table 2).

Table 2

Comparison of Means

Verbal probability expression	Theil (2002) n	Range		Mean of means	Experiment L1	SD	L2	SD
Rare	6	5.00	13.81	9.50	9.86	9.22	14.58	17.615
Very unlikely	4	9.00	28.44	15.84	11.71	12.771	13.9	18.79
Unlikely	6	14.00	31.42	20.83	14.49	12.752	20.65	16.654
Possible	6	63.00	77.00	69.33	52.49	21.467	56.84	19.258
Likely	6	27.00	47.10	40.66	68.94	20.035	64.24	18.587
Probable	5	64.50	74.66	68.43	62.11	22.984	59.67	18.733
Good chance	4	72.30	82.18	74.87	71.37	20.123	70.82	20.285
Frequent	4	56.00	81.16	72.29	75.17	26.568	71.16	22.474
Usually	4	73.71	77.00	74.65	73.31	14.546	72.63	18.968
Very probable	4	82.50	87.00	83.00	77.94	22.08	76.76	19.005

Table 3: Comparisons of Theil (2002) to L1 & L2 participants' mean isolation scores.

Condition 2. VPE– Random Event - Numerical Range

Procedure. Verbal probability expressions (VPEs) were presented and subjects were asked to assign a low range number and high range number. This condition was a replication, with minor wording differences, of a study conducted by Hamm (1991) whose participants were instructed to assign upper and lower numerical limits for events that changed only in terms of the verbal expression used. Numbers were provided in ranges of 3, e.g. 0-3, 4-6, 7-9.

Condition 2 results. Descriptive statistics for L1 and L2 participants are shown in Table 3 below.

Table 3

L1 vs. L2 VPE ranges

Verbal probability expression	L1 mean-low	L1 mean-high	spread	L2 mean-low	L2 mean-high	spread
Rare	11.73	22.97	11.24	10.56	18.58	8.02
Very unlikely	10.64	25.70	15.06	11.54	21.69	10.15
Unlikely	11.45	24.76	13.31	15.80	27.21	11.41
Possible	44.73	68.73	24.00	48.41	68.90	20.49
Likely	54.27	71.00	16.73	51.76	68.24	16.48
Probable	50.64	70.61	19.97	53.00	69.73	16.73
Good chance	56.73	73.00	16.27	62.39	77.80	15.41
Frequent	60.48	76.30	15.82	60.44	74.53	14.09
Usually	61.76	73.48	11.72	62.46	77.16	14.70
Very probable	64.09	82.06	17.97	65.50	81.20	15.70

Table 4: High and low mean scores for verbal probability expressions random event, numerical range, and L1 & L2 participants.

Condition 2 discussion. Condition 2 results can be analyzed within and between subjects. Within subject comparisons show overall consistency between probabilities elicited in Condition 1 and Condition 2. That is, subjects' scores from Condition 1 generally match the scores in Condition 2. All but one of the participants' isolation scores fell within the low and high numbers ranges elicited in Condition 2. L1 participants in the isolation condition scored 'rare' as 9.86, while listing the range for 'rare' from 11.73 – 22.97. On the other hand, between subject comparisons show that L1 speakers' score spreads are higher in nine out of the ten VPEs. Spread, for the purposes of this discussion, is the size of the difference between mean low scores and mean high scores. 'Usually' is the only VPE in which L2 speakers show a larger spread.

Condition 3. VPE in Context – Monthly Event – One Number

Procedure. Verbal probability expressions (VPEs) were embedded in sentences. Subjects were asked to assign one number to each VPE in sentences in order to examine how context (Hamm, 1991) affects VPE estimates. Condition 3 was patterned after Teigen & Brun's (2003) study in which participants were asked to complete the same sentence with multiple VPEs. 'Context' in Condition 3 is defined at the sentence-level. VPEs modify actions that take place over the course of a month (jogging). Context differs from 'framing,' a JDM construct, and 'sense,' a psycholinguistic construct. Framing uses positive phrases ('probable') and negative phrases ('doubtful') to test assessments of verbal probability (Teigen & Brun, 2003). Sense refers to the "priming between semantically related words depends on the proportion of shared senses" (Finkbeiner et al., 2004). Both framing and sense are worthwhile to test in future VPEs experiments with first and second language speakers.

Condition 3 results. Descriptive statistics for L1 and L2 participants are shown in table 4. Comparing L1 and L2 mean scores show that L2 subjects' mean scores are higher than L1 participants' mean scores in all 10 verbal probability expressions. For Spanish (n=33) and Portuguese (n=50) participants the effect is the strongest given that in all sentences Spanish and Portuguese speakers assessed the same VPEs higher than L1 participants. This affect weakens with Arabic (n=49) and Chinese (n= 11) participants (see table 5).

Table 4

L1 vs. L2 VPE monthly context

Verbal probability expression	L1 mean	L2 mean
Rare	5.64	7.03
Very unlikely	3.09	6.99
Unlikely	6.48	11.49
Possible	23.33	29.73
Likely	32.12	33.44
Probable	25.88	32.24
Good chance	35.85	38.14
Frequent	35.48	40.83
Usually	39.45	40.91
Very probable	37.73	39.9

Table 4: Mean scores for verbal probability expressions monthly condition event, L1 & L2

participants.

Table 5

L1 vs. L2 VPE monthly context

Verbal probability expression	L1 mean	Spanish (n=33)	Portuguese (n=50)	Chinese (n=11)	Arabic (n=49)
Rare	5.64	8.15	5.90	12.09	6.76
Very unlikely	3.09	6.39	7.22	15.27	5.71
Unlikely	6.48	13.61	10.90	25.55	8.24
Possible	23.33	36.03	33.70	29.27	23.59
Likely	32.12	39.12	37.80	31.00	27.80
Probable	25.88	40.36	35.42	31.73	25.59
Good chance	35.85	42.67	44.80	34.55	31.57
Frequent	35.48	48.03	47.80	44.00	30.67
Usually	39.45	47.67	40.40	43.18	38.86
Very probable	37.73	51.30	44.28	32.45	31.76

Table 5: Mean scores for VPEs monthly condition event, L1 & Spanish, Portuguese, Arabic, Chinese participants.

Condition 3 discussion. Condition 3 results can be analyzed within and between subjects. Within subject comparisons show that subjects provide lower numerical probability assessments in Condition 3 than in both Condition 1 and Condition 2 in every VPE. That is, participants seem to be more judicious with their probability assessments in the monthly context than in either in the isolation or range conditions. Between subject comparisons, on the other hand, show the L2 participants overall provided higher probabilities for all 10 VPEs than L1 participants. Language-specific comparisons show varied results. Spanish and Portuguese participants provided higher probabilities for all 10 VPEs than L1 participants, Chinese participants provided higher probabilities for 7 of the 10 VPEs than L1 participants while Arabic participants provided higher probabilities the four lowest VPEs – *rare*, *very unlikely*, *unlikely*, and *possible* – while they provided lower probabilities the six highest VPEs – *likely*, *probable*, *good chance*, *frequent*, *usually*, *very probable*. In order to tease these findings apart, follow up studies to compare similar VPEs in subjects native languages will be conducted.

Condition 4. VPE in Context – Daily Event – One Number.

Procedure. The procedure for Condition 4 was identical to the procedure used in Condition 3. Once again 'context' is defined at the sentence-level, but the VPEs modify actions that take place over the course of a day (checking Facebook), instead of a month (jogging).

Condition 4 results. Descriptive statistics for L1 and L2 participants are shown in table 6. Comparing L1 and L2 mean scores show that L2 subjects' mean scores are higher than L1 participants' mean scores in all 10 verbal probability expressions; this is the same result found in Condition 3.

Table 6

L1 vs. L2 VPE monthly context

Verbal probability expression	L1 mean	L2 mean
Rare	3.00	6.74
Very unlikely	3.33	8.24
Unlikely	5.60	10.94
Possible	21.67	31.32
Likely	25.23	32.52
Probable	25.73	32.64
Good chance	28.53	37.35
Frequent	30.33	36.78
Usually	29.33	39.99
Very probable	32.40	41.65

Table 6: Mean scores for verbal probability expressions daily condition event, L1 & L2 participants.

Unlike Condition 3 in which higher probability scores were found strongest in the Spanish and Portuguese speakers, results from Condition 4 show that second language speakers gave higher probability scores in all VPEs expect for one instance. Arabic speakers scored ‘frequent’ at 29.29 while L1 speakers scored ‘frequent’ at 30.33. See table 7.

Table 7

L1 vs. L2 VPE monthly context

Verbal probability expression	L1 mean	Spanish (n=33)	Portuguese (n=50)	Chinese (n=11)	Arabic (n=49)
Rare	3.00	6.76	3.9	19.73	7.16
Very unlikely	3.33	6.82	9.24	13.36	7.61
Unlikely	5.60	12.03	10.54	15.09	10.47
Possible	21.67	37.58	31.52	33.45	28.69
Likely	25.23	32.33	36.02	32.45	31.43
Probable	25.73	38.52	35.08	31.36	28.84
Good chance	28.53	37.33	43.82	38.45	33.24
Frequent	30.33	36.91	45	43.45	29.29
Usually	29.33	41.06	40.04	44.91	40.73
Very probable	32.40	43.09	45.8	59.18	35.45

Table 7: Mean scores for VPEs daily condition event, L1 & Spanish, Portuguese, Arabic, Chinese participants.

Condition 4 discussion. Condition 4 results can be analyzed within and between subjects. Within subject comparisons show that subjects provide lower numerical probability

assessments in Condition 4 than in both Condition 1 and Condition 2 in every VPE. This is the same finding for Condition 3.
That is, participants seem to be more judicious with their probability assessments in the daily context than in either the isolation or range conditions. Between subject comparisons, on the other hand, show the L2 participants overall provided higher probabilities for all 10 VPEs than L1 participants. Language-specific comparisons show that the higher probabilities are stronger across language groups.

INFERENTIAL RESULTS

In this section, main and interaction effects from a repeated measures analysis of variance (ANOVA) test will be reported for within-group, between-group tests, and interaction effects. Additionally, post-hoc tests are reported.

Assumptions & Violations

Mauchly probabilities, chi-square, df, and significance tests for each condition are given below. Based on Mauchly's test of sphericity in each of the conditions, the conclusion is that there are significant differences between the variances of the differences. In Condition 1, the Mauchly probability is .013 and in conditions 2-4, the Mauchly probability is .000.

condition 1. Mauchly's W = .013; chi-square 82.293, df =44, . Sig = .001
condition 2. Mauchly's W = .000; chi-square 434.352, df =189, . Sig = .000
condition 3. Mauchly's W = .000; chi-square 243.728, df =44, . Sig = .000
condition 4. Mauchly's W = .000; chi-square 316.024, df =44, . Sig = .000

Given the potential violation of this assumption, the corrected model using value for sphericity assumed is reported.

Effects and Post-Hoc Observations

Two effects are reported for each condition: 1) within-group VPE effects and 2) between-group VPE effects. Post-hoc inspections and charts are also provided for each condition. The charts show estimated marginal means for each VPE: 1 = rare, 2 = very unlikely, 3 = unlikely, 4 = possible, 5 = likely, 6 = probable, 7 = good chance, 8 = frequent, 9 = usually, 10 = very probable.

Condition 1. The within-group VPE effects are F (9, 198), 86.153 $p < 0.001$. The between group VPE effects are F(1, 22) = .023, p = .880. The interaction results between the VPE in isolation and groups are F (9, 198), 1.838, $p < 0.001$. A post-hoc inspection shows less overlap on the lower areas of the VPE spectrum (e.g. *rare, very unlikely, unlikely, and possible*) than in the middle and higher areas of the VPE spectrum. *Likely*, *probable, good chance, frequent, usually, and very probable* overlap with other VPEs 4-6 times while *rare, very unlikely, unlikely,* and *possible* overlap with other VPEs 2 times each. Chart 1 shows the estimated marginal means of the isolation VPEs.

Condition 2. The within-group VPE effects are F = (19, 418), 82.674, $p < 0.001$ and the between group VPE effects are F(1, 22) = .018, p = .894. The interaction results between the VPEs in range and groups are F (19, 418), .993, $p < 0.001$. A post-hoc inspection shows again less overlap on the lower VPE spectrum (e.g. rare, very unlikely, unlikely) than in the middle and higher areas of the VPE spectrum. *Possible, likely*, *probable, good chance, frequent, usually, and very probable* overlap with other VPEs 14-19 times while *rare, very unlikely,* and *unlikely* overlap with other VPEs 6-7 times each. Chart 2 shows the estimated marginal means of range VPEs.

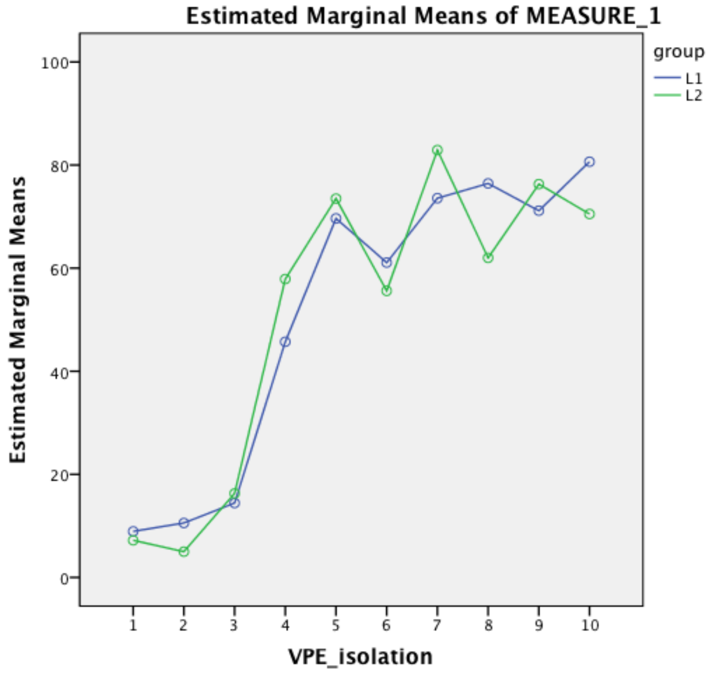

Chart 1: Estimated marginal means of the isolation VPEs.

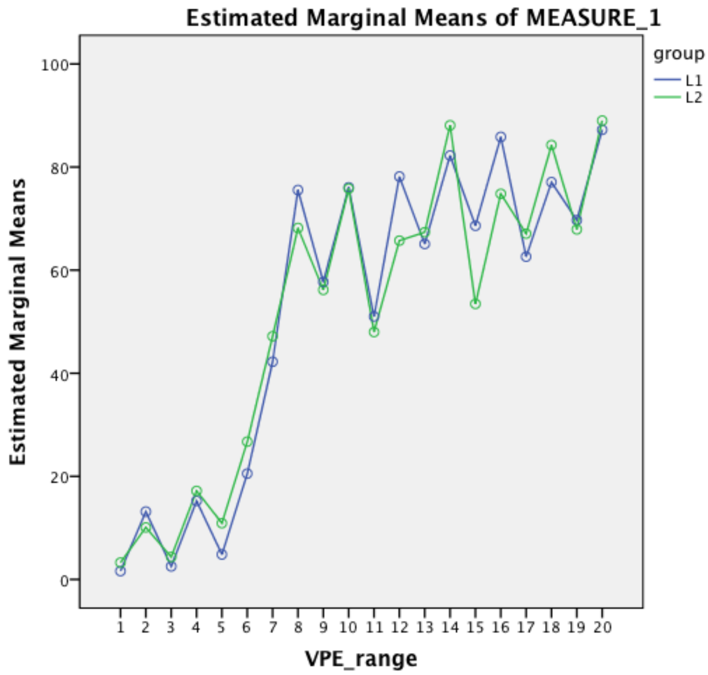

Chart 2: Estimated marginal means of range VPEs.

Condition 3. The within-group VPE effects are F (9, 216) = 22.571, p < .001.The between group VPE effects are F(1, 22) = .023, p = .376. The interaction results between the monthly condition VPE and groups are F (9, 216), .699, p < 0.001. A post-hoc inspection shows less overlap on the lower the VPE spectrum (e.g. rare, very unlikely, unlikely) than in the middle and higher areas of the VPE spectrum. *Possible, likely*, *probable, good chance, frequent, usually, and very probable* overlap with other VPEs 4-8 times. *Rare, very unlikely,* and *unlikely* overlap with other VPEs 3 times each. Chart 3 shows the estimated marginal means of the monthly VPEs. Unlike the overlapping estimates provided by L1 and L2 subjects in the isolated and range conditions, L1 subjects provide higher scores for VPEs in a monthly context than L2 subjects except for *very unlikely*.

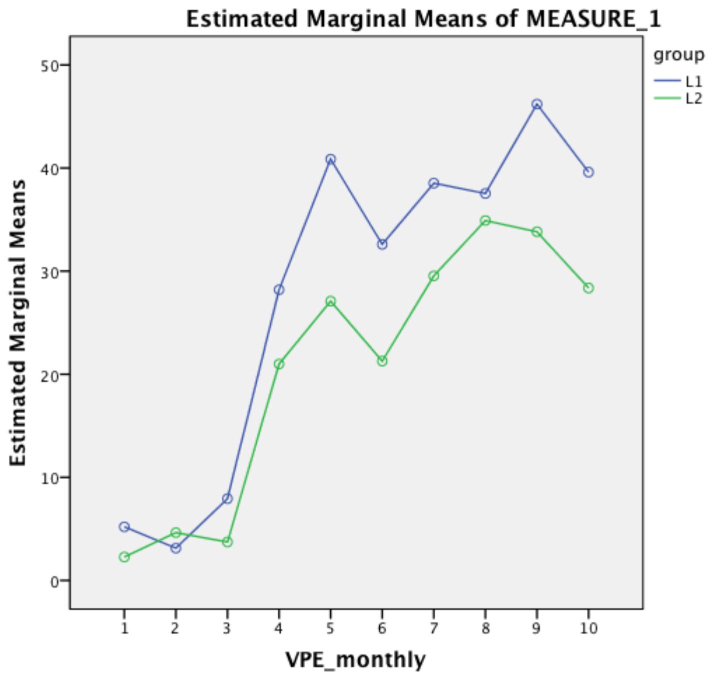

Chart 3: Estimated marginal means of monthly VPEs.

Condition 4. The within-group VPE effects are F (9, 216) = 13.365, p < .001.The between group VPE effects are F(1, 22) = .244, p = .05. The interaction results between the daily condition VPE and groups are F (9, 216), 1.287, p < 0.001. A post-hoc inspection shows uneven overlap on the VPE spectrum. For example, *rare* overlaps 6 times which is equal to *frequent* and *usually* which also overlap 6 times. Chart 4 shows the estimated marginal means of the daily VPEs. Unlike the overlapping estimates provided by L1 and L2 subjects in the isolated and range conditions, L1 subjects provide higher scores in the monthly VPEs than L2 subjects in every case.

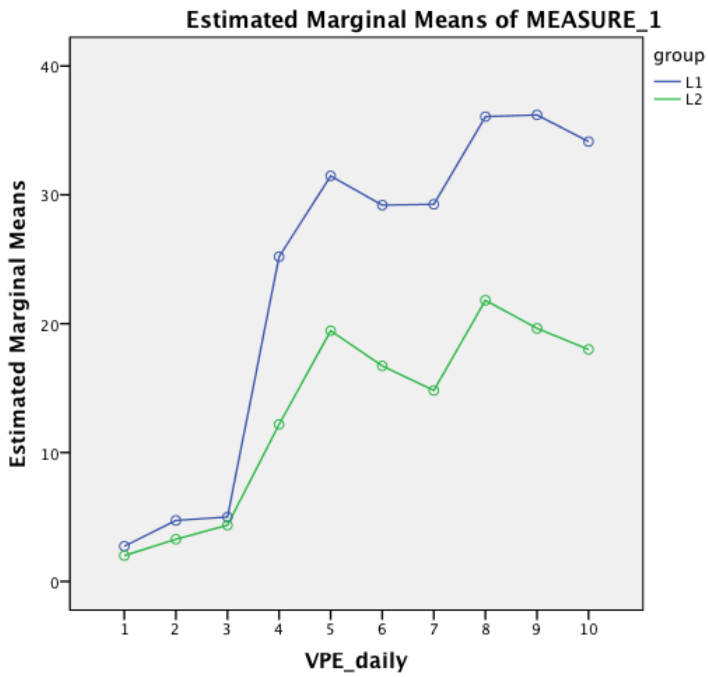

Chart 4: Estimated marginal means of daily VPEs.

GENERAL DISCUSSION

The two-tailed hypothesis refers to the idea that differences exist between L1 and L2 speakers' numerical assessments of 10 verbal probability expressions. Descriptive statistics in Condition 1 indicate few meaningful differences in L1 and L2 VPE assessments. From the repeated measures and post-hoc tests, only *very unlikely* shows little overlap with other VPE estimates and potentially significant differences in marginal mean scores. L1 speakers Condition 1 estimates fall outside Condition 2 estimates in 5 of 10 VPEs. Four assessments were lower than the lowest score and 1 assessment was higher than reported by Theil (2002). L2 speakers Condition 1 estimates fall outside Condition 2 estimates in 6 of 10 VPEs. Four assessments were lower than the lowest score and 2 assessments were higher than reported by Theil (2002). Given more data, estimates would be predicted to fit the range of mean scores found in Theil's (2002) review paper. Descriptive statistics in Condition 2 show no clear patterns. As in Condition 1, only *rare, very likely,* and *unlikely* have little overlap with other VPEs.

Conditions 3 and 4 results are more interesting. Descriptive statistics in Condition 3 show that in 9 out of 10 VPEs, L1 mean scores are higher. The average difference is 8.30 with a range of 2.62 – 13.78. Descriptive statistics in Condition 4 show that in 10 out of 10 VPEs, L1 mean scores are higher. The average difference is 10.17 with a range of 2.97 - 16.56. Overall, L1 speakers' estimates are higher than L2 speakers in contexts. Both charts 3 and 4 are noteworthy because the L1 and L2 estimates for *possible, likely, probable, good chance, frequent, usually,* and *very probable* show clear separations.

Verbal probability assessments of the VPEs tended to drop from Condition 1 to Condition 4. Condition estimates were calculated by adding the low and high means for each VPE and dividing by 2. L1 speakers lowered their estimate for each condition in 5 of 10 VPEs. L1 speakers' estimates for *likely* gradually lowered from 69.64, 66.89, 40.87, to 31.47. In the 4 instances when the Condition 2 estimate was higher than the Condition 1 estimate and the one instance when the Condition 4 estimate was higher than the Condition 3 estimate, 3 of the 5 increases were less than 6%. The estimate of *very unlikely* rose from 3.13 to 4.73 (51%) from Condition 3 to Condition 4. The estimate of *possible* rose from 45.71 to 58.89 (29%) from Condition 1 to Condition 2.

Likewise, L2 speakers also lowered their estimate for each condition in 5 of 10 VPEs. L2 speakers' estimates for *likely* gradually lowered from 73.50, 66.00, 27.09 to 19.45. In the 5 instances when the Condition 5 estimate was higher than the Condition 1 estimate and the 1 instance when the Condition 4 estimate was higher than the Condition 3 estimate, 5 of the 6 increases were less than 17%. The estimate of *very unlikely* rose from 5.00 to 10.77 (115%) from Condition 1 to Condition 2. Future studies will focus on fine-grained differences of L1 and L2 speakers on context questions.

These preliminary results are promising. First, the results provide an initial glimpse into how decisions may differ for first- and second-language speakers. Thy represent one of the first attempts to study decision making through the lens of an applied linguist and an important attempt to examine language behavior outside of the classroom. The results, at the very least, suggest that attempting to replicate the findings is worthwhile for decision making and applied linguistics researchers.

IMPLICATIONS

There are implications of bilingual decision making in environments in which both first- and second-language speakers make consequential decisions, such as in 1) medical decision making, 2) legal decision making, and 3) managerial decision making. Medical decision making is the study of decisions in medical contexts with an eye to improve the health and clinical care of individuals and to assist with health policy development (Medical Decision Making Journal, 2015). Scholars of legal decision making study the psychological and emotional factors of legal decision making made by jurists and jurors (Legal Decision Making Research Lab, University of Nebraska-Lincoln, 2015). Managerial decision making is the study of negotiation, investment decisions, and managerial decisions (Bazerman & Moore, 2012). What each of these sub-areas of decision making have in common is that they have not specifically addressed whether and how the decisions second-language speakers, bilingual speakers, and trilingual speakers may be variant as a function of one's language competence.

Acknowledgements

I would like to acknowledge the people at the University of Arizona who created Graduate Interdisciplinary Programs because without them I would not have been able to take course in 6 colleges to come across this research. I'd especially like to thank Dr. Tom Bever (co-chair) in linguistics and psychology, Dr. Linda Waugh in French and humanities (co-chair), Dr. Lisa Ordoñez in management, Dr. Robertson in law, and Shaun Nichols (philosophy) who allowed me to seek out new research.

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APPENDIX A

1) VPE in isolation – no event – one number

Please write a number between 0-100 next to the word. The number you write indicates how often (percentage) you believe the word indicates. For example if you see “always” you may write “100” and if you see “never” you may write “0.”

Very unlikely	_____
Frequent	_____
Very probable	_____
Usually	_____
Rare	_____
Unlikely	_____
Possible	_____
Good chance	_____
Likely	_____
Probable	_____

APPENDIX B

2) VPE – random event – numerical range

Below is a list of words that express degrees of uncertainty.

Assume that you are using each word to describe the chance of drawing a white ping pong ball from the tray of 100 yellow ping pong balls.

For each sentence, please choose the lower and upper numerical limits that you would expect your friend to use in interpreting the word given the chance of drawing a white ping pong ball from a tray of 100 yellow ping pong balls. Numbers are provided in ranges of 3, e.g. 0-3, 4-6, 7-9.

	Lower Limit	Upper Limit
Likely	_____	_____
Usually	_____	_____
Probable	_____	_____
Very unlikely	_____	_____
Very probable	_____	_____
Rare	_____	_____
Good chance	_____	_____
Frequent	_____	_____
Possible	_____	_____
Unlikely	_____	_____

APPENDIX C

3) VPE in context – monthly event – one number

Below is a list of sentences. In each sentence there is a word in parenthesis such as "always" or "never."

Write a number to indicate the number indicated by the word in parenthesis.

If Sandra "usually" goes jogging, how many times per month does Sandra go jogging?	_____
If it is "likely" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____
If it is "frequent" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____
If it is very "probable" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____
If there is a "good chance" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____
If it is "rare" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____
If it is "very unlikely" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____
If it is "unlikely" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____
If it is "probable" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____
If it is "possible" for Sandra to go jogging, how many times per month does Sandra go jogging?	_____

APPENDIX D

4) VPE in context – daily event – one number

Below is a list of sentences. In each sentence there is a word in parenthesis such as "always" or "never."

Write a number to indicate the number indicated by the word in parenthesis.

If it is "probable" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____
If it is "very unlikely" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____
If there is a "good chance" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____
If it is "frequent" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____
If it is "unlikely" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____
If it is "very probable" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____
If Sam "usually" logs in to Facebook, how many times per day does Sam log in to Facebook?	_____
If it is "possible" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____
If it is "likely" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____
If it is "rare" for Sam to log in to Facebook, how many times per day does Sam log in to Facebook?	_____