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The Development and Validation of a Spanish Elicited imitation Test of Oral Language Proficiency for the Missionary Training Center

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ABSTRACT

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The Missionary Training Center (MTC), affiliated with the Church of Jesus Christ of Latter-day Saints, needs a reliable and cost effective way to measure the oral language proficiency of missionaries learning Spanish. The MTC needed to measure incoming missionaries' Spanish language proficiency for training and classroom assignment as well as to provide exit measures of institutional progress. Oral proficiency interviews and semi-direct assessments require highly trained raters, which is costly and time-consuming.

The Elicited Imitation (EI) test is a computerized, automated test that measures oral language proficiency by having the participant hear and repeat utterances of varying syllable length in the target language. It is economical, simple to administer, and rate. This dissertation outlined the process of creating and scoring an EI test for the MTC. Item Response Theory (IRT) was used to analyze a large bank of EI items. The best performing 43 items comprise the final version MTC Spanish EI test.

Questions about what linguistic features (syllable length, grammatical difficulty) contribute to item difficulty were addressed. Regression analysis showed that syllable length predicted item difficulty, whereas grammar difficulty did not.

Keywords: elicited imitation, oral proficiency assessment, automatic speech recognition, ASR, second language proficiency testing, Spanish second language testing, IRT, Item Response Theory

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Chapter 1: Introduction

In the field of linguistics and foreign language education, there is an ongoing need for assessment of language proficiency. There are three major approaches to testing oral language proficiency: oral proficiency interviews, semi-direct tests and automated tests (Bernstein, Van Moere, & Cheng, 2010). Oral proficiency interviews and semi-directs tests require highly trained raters which is costly and time-consuming. Automated tests are administered on a computer and rated automatically by speech recognition software. Automated test eliminate the need for highly trained raters, therefore reducing the time and cost needed to administer and rate oral language proficiency.

The Church of Jesus Christ of Latter-day Saints' Missionary Training Center (MTC) teaches foreign language to pre-service missionaries. The MTC teaches 55 different languages. It trains approximately 19,000 missionaries in a year. The MTC teaches a general lexicon but also a specialized corpus of religious context vocabulary.

At the beginning of their service, missionaries learning another language usually spend three to twelve weeks at a Missionary Training Center (MTC) in Provo, Utah. At present, approximately half of the missionaries studying another language at the Provo MTC are learning Spanish (roughly 1,000). With so many Spanish language learners, the task of assessing their language proficiency requires a lot of resources, time and effort. Because of the specialized language being taught, the MTC needs a custom, valid Spanish oral language proficiency measure that is easy and practical to administer and rate.

Missionary Training Center Spanish Language Proficiency Measures

Currently there are two Spanish proficiency measures used at the MTC: a placement measure and an exit measure. The placement measure is used to make classroom assignments and the exit measure is used to gather institutional progress reports.

Measures. When missionaries apply for mission service, they indicate whether or not they have prior language experience (e.g., studied it in school, lived in another country). Missionaries who are assigned to a Spanish-speaking mission and indicate a certain level of prior language experience in Spanish receive a phone call from an MTC employee several weeks preceding their arrival date and are asked several questions in Spanish in order to determine their level of proficiency. As a result of these interviews, these missionaries are given a language proficiency score on a scale from one to seven. Missionaries who receive a placement score of one or two are placed in beginning level classrooms and stay at the MTC for nine weeks. Those who receive a three or four are placed in an intermediate level classroom and also stay at the MTC for nine weeks. Those who receive a five, six or seven are placed in an advanced level classroom and stay at the MTC for three weeks.

Every week at the MTC, a randomly selected subset of exiting missionaries is tested on various criteria (e.g., doctrinal knowledge, study skills) for institutional progress reports. One of these measures for language missionaries is the Language Speaking Assessment (LSA)–a computerized audio-response assessment that elicits spontaneous speech from the missionaries. The LSA was developed by the MTC using the American Council on the Teaching of Foreign Languages (ACTFL) Proficiency Guidelines (Breiner-Sanders et al., 2000). Missionaries read and respond to a prompt (e.g., “Tell about yourself”). Their responses are recorded and a trained rater listens to their responses and gives four separate ratings in the areas of pronunciation, grammar, vocabulary and fluency, which are aggregated to one overall language proficiency score.

Challenges. There are some challenges with the current placement procedures. Because current procedures are cumbersome, not all missionaries who should receive placement interviews are actually interviewed. Also, placement ratings are sometimes inaccurate because the ratings are quite subjective. This becomes problematic because errors in placing missionaries into the correct training program causes significant logistical and scheduling problems due to the need to reassign classes and can become quite costly to the MTC. Additionally, such adjustments in training times affect entrance dates into the mission field.

After missionaries' training, they should receive an exit assessment of their proficiency as an estimate of the effectiveness of training. Pragmatically, this has proved to be very difficult with the number of missionaries to be assessed. Hiring and training LSA raters is a costly, never-ending process. Because of the difficulty in training and hiring good raters, LSA ratings can be inaccurate. Inaccurate language proficiency exit scores hinder the MTC's ability to measure the institution's impact on teaching Spanish to missionaries. Because of the challenge in the current procedure, the MTC needs a practical, accurate and inexpensive instrument to measure Spanish oral language proficiency. If a more efficient method of measuring language could be implemented prior to entering and exiting the MTC, many of these problems could be eliminated. An instrument that is more economical and objective that is also valid and reliable would be a welcome improvement to the language training and assessment process at the MTC.

Elicited Imitation Proficiency Measures

The MTC currently uses interviews and semi-direct test proficiency tests. They are quite interested in developing and using automated tests of Spanish oral language proficiency. Elicited

Imitation (EI) tests are computerized automated tests that measure oral language proficiency by having a participant hear and repeat sentences of varying syllable length in the target language. They are economical and simple to administer and rate. An EI sculpted to the specific needs of the MTC could provide a way to measure incoming missionaries' Spanish language proficiency for training and classroom assignments as well as provide exit measures of institutional progress.

Statement of Purpose and Research Questions

The purpose of this project is to develop and validate a Spanish Elicited Imitation test that will reliably and accurately measure oral language proficiency skills for missionaries learning Spanish at the MTC. Additionally, this project will investigate how sentence length and grammatical difficulty contribute to the overall difficulty of an item. This study will be guided by the following research questions:

1. What does an MTC Spanish Elicited Imitation test consist of?
2. What is the process for creating an elicited imitation test?
3. What is the correlation between automatic speech recognition (ASR) scoring with hand scoring of an MTC Spanish EI?
4. What makes an item difficult? What is the main effect of grammar? What is the main effect of sentence length? Is there an interaction between grammar and sentence length?

Chapter 2: Literature Review

This review of literature covers several themes. First, it provides a general overview of current oral second language proficiency measures and practices. Second, the history of language testing at the MTC is discussed. Third, the review summarizes the literature on using Elicited Imitation (EI) tests as overall second language proficiency measures including EI history, premise, uses, strengths, limitations, design, development, administration, and scoring. Lastly, this review discusses the statistical analysis methods used to validate and calibrate EI tests, as well as the analysis of linguistic features of items that may contribute to item difficulty.

Overview of Language Proficiency Testing

At present there are three main approaches to testing oral language proficiency: (a) Oral Proficiency Interviews, (b) semi-direct tests, and (c) automated tests (Bernstein et al., 2010). Oral proficiency interviews (OPIs) are carefully constructed conversations between a highly trained rater and a test taker. Through a series of questions, the rater tries to elicit a ratable speech sample and then assigns a proficiency score based on the complexity and accuracy of the speech sample (Buck, 1989). Oral Proficiency Interviews are often considered the “gold standard” of language testing because they closely mirror authentic language situations. However, OPIs require time and money. Interviews (or phone interviews) can take 15-30 minutes and the current cost for an official ACTFL OPI is $134[1].

Semi-direct tests of oral proficiency use computers to present tasks to elicit language. The test-takers’ responses are recorded and then evaluated by raters according criteria similar to the OPI. These semi-direct tests are considered very comparable to, yet more reliable than, live tests (Stansfield and Kenyon, 1992). Examples of semi-direct tests include the Computer Assisted Screening Tool (CAST) (Malone, 2007) and the Computerized Oral Proficiency

[1] http://www.actfl.org/i4a/pages/index.cfm?pageid=3385

Interview (COPI)[2]. Even though semi-direct tests can be taken anywhere at any time and thus eliminate the need for face-to-face (or phone) interaction between rater and the test-taker, they still require highly trained raters which is both costly and time-consuming.

Lastly, automated tests use a series of recorded prompts that are presented to a test-taker and then the test-taker gives a spoken response in real time. These tasks includes the repetition of sentences, short questions, sentence builds and passage retells. The test-takers' responses are recorded and then analyzed by computer procedures. Scores are given based on sentence mastery, vocabulary, fluency and pronunciation (Bernstein et al., 2010). Examples of automated tests include the Versant tests (Pearson, 2009b), the speaking tasks within the Pearson Test of English (Pearson, 2009a), the speaking section of the TOEFL iBT practice tests (Zechner, Higgins, XI, Williamson, 2009), and oral response elicitation tools and elicited imitation tests (EI) (Graham, 2008). Automated tests eliminate the need for face-to-face interaction and highly trained raters.

Language Testing at the MTC

In the 1970s the Foreign Service Institute (FSI) assessed language proficiency using an oral language interview. About this time administrators and researchers at the MTC recognized a need to test the language proficiency of missionaries who were learning a second language. Therefore, the MTC contacted the Educational Testing Services (ETS) who sent a representative to train raters on administering and scoring the FSI test with missionaries. Unfortunately, there were several drawbacks with using the FSI test with missionaries at the MTC. The FSI test did not adapt well to the unique context of missionary work nor did it discriminate well among different levels. Over time, administering and scoring the FSI became challenging and expensive (Moulton, 2012).

[2] http://www.cal.org/topics/ta/copi.html

In the early 1990s, the MTC developed an internal language proficiency instrument that incorporated the missionary context. The instrument was called the Modern Language Performance Test (MLPT). The MLPT was an in-person role-play test conducted by trained testers. The test engaged missionaries in language tasks of increasing difficulty and then gave them a rating on five criteria: pronunciation, grammar, vocabulary, comprehension, overall task performance (Bateman, 1995). The test was used at the MTC throughout the 1990's but eventually the MTC stopped using it because they could only test and rate a subset of missionaries due to the time and cost of administration and rating. Additionally, changes in MTC curriculum moved away from missionaries teaching fixed discussions and this change rendered the MLPT content obsolete.

However, around that time new technologies in semi-direct language testing were developing in the language testing community. The MTC decided to create a more efficient and practical language semi-direct testing instrument (Moulton, 2012). In 2004, the MTC developed such a proficiency instrument called the Language Speaking Assessment (LSA). The LSA is a web-based assessment developed by a team of language experts at the MTC and is currently considered the "gold standard" of missionary language testing. The LSA is based on criteria from (a) the MLPT, (b) guidelines set up by the American Council on the Teaching of Foreign Languages (ACTFL) and (c) the scoring rubric used to rate OPIs [3]. To take the LSA, missionaries (a) read a prompt, (b) prepare to respond (30-60 seconds), and (c) orally respond to the prompt (30 seconds to 3 minutes) (Moulton, 2012). Subsequently, trained raters listen to the recorded audio responses and assign four ratings on a seven point scale for pronunciation, grammar, fluency, and vocabulary. The four ratings are aggregated to one overall proficiency rating.

[3] http://www.actfl.org/files/public/ACTFLProficiencyGuidelines2012_FINAL.pdf

The LSA is currently used at the MTC and in the mission field to assess language proficiency. This instrument has provided valuable insight into missionaries' language abilities and it has allowed more missionaries to participate in language testing. However, just like other semi-direct instruments, the LSA has the pragmatic limitation of requiring human raters to listen to and rate all of the recordings.

Recently, the MTC administration has expressed interest in finding an additional valid language proficiency measure that could more practically measure language proficiency while obtaining a high correlation with the LSA. Recently, the MTC developed an English elicited imitation test for non-native missionaries learning English (Moulton, 2012). The MTC English EI hand rating score correlated fairly strongly with the MTC's LSA (*r* = 0.83) (Moulton, 2012). Moulton's pilot was encouraging; however, because of time constraints her method was not as refined as current test development practices would require. There were limitations in her item selection criteria, the initial item pool and the sample size. Her item analysis was restricted to classical test theory item difficulty estimates. Also, the elicitor was chosen by convenience and not carefully screed for neutrality of accent. She did, however, coordinate the creation of an automatic speech recognition (ASR) engine to score the tests. Because of promising results with the MTC English EI, MTC administrators and researchers were eager to develop a Spanish elicited imitation test for the largest population of language-learning missionaries.

Any attempt to create a Spanish EI would need to use more refined test development practices. The literature on developing and validating EI tests covers a variety of topics including test validity, uses, design, administration, and scoring. The literature shows that some methods are better than others in developing valid and reliable EI measures.

Elicited Imitation

Elicited imitation, as a measure of second language proficiency, has been met with criticism and skepticism because of its apparent lack of validity. Using EI as a measure of language proficiency was popular in the 1970s (Naiman, 1974). However, Hood and Lightbrown (1978) argued that EI tests did not fit requirements of proper research methods. They questioned the validity and reliability of the EI to measure linguistic knowledge. Language testing practitioners have been slow to accept elicited imitation because "it is hard for them to see how repeating sentences orally can measure something as complex as oral language proficiency" (Graham et al., 2008a, p. 57). Because of Hood and Lightbrown's criticism, EI lost some popularity. Despite this loss in popularity, researchers in the 1980s continued to evaluate the EI as a measure of linguistic competencies.

Gallimore and Tharp (1981) found that EI produced stable test-retest correlations and that it was related to language behavior in natural settings, and reflected stages of language development. Even though there were questions of face validity, researchers concluded that EI works, but at that time, they did not know how or why (Vinther, 2002).

Critics also questioned the ability to know whether the test-taker is really using linguistic knowledge to understand and repeat an utterance or is merely imitating a chain of sounds without understanding meaning by holding the information in short-term memory—a process called "parroting" by some researchers (Vinther, 2002).

Elicited imitation does involve working memory. Working memory contains information held momentarily as needed to analyze, solve a problem or perform a task (Cowan, 1996). Miller's (1956) research on working memory discussed the "magic number" of 7 ± 2, based on the observation that a person can generally hold up to seven completely unrelated items in their mind simultaneously. Miller also introduced the process of recoding, now more commonly referred to as “chunking”. Chunking takes multiple separate items and compiles them into patterns, reducing the number of items to remember and speeding up processing.

In a recent study (Okura & Lonsdale, 2012), researchers investigated the role of working memory with second language elicited imitation tasks. They administered two tests to the same group of students studying English as a second language: (a) a working memory test, and (b) an English EI test. Their results indicated that the correlation between the working memory scores and the elicited imitation scores were not significant. Therefore, parroting does not seem to be a factor with using elicited imitation tests to measure second language proficiency because the utterance that test-takers are asked to repeat moved beyond the ability of the working memory.

Theoretical underpinnings. In 1994, Bley-Vroman and Chaudron published a breakthrough article describing how EI works. They explained that EI is a psycholinguistic technique used to test language ability. They described that there is a correlation between a test-takers’ knowledge of a language and their ability to repeat elicited utterances.

Bley-Vroman and Chaudron (1994) described further how the elicited imitation process works. A test-taker hears the utterance and processes it, forming a representation in their memory. Because working memory can only handle a certain number of items, test-takers will “chunk” groups of words together so more information can be stored in the short-term memory. Chunking occurs when test-takers hear and process an utterance, and then form a meaningful representation that can be stored. Test-takers who are more proficient in the language have a greater capacity to chunk longer sentences into manageable units and keep those units in their short-term memory.

The representations of meaning stored in their memories include information at various levels including visual, orthographic, syllabic, lexical, phrasal, structure, logical, and interpretive. Test-takers create a representation that is based on as many levels as possible in order for the representation to be as complete as possible. The more proficient the test-takers are in the language being examined, the more levels they can access to create their representation of the utterances. The test-takers then produce an utterance based on the representation they have been able to construct. Again, the more proficient the test-takers in the language being examined, the more effective they are at the automatic formulation of a representation and the more accurate the reconstruction of utterances (Bley-Vroman & Chaudron, 1994). Therefore, if test-takers are presented with a variety of sentences that vary in length and difficulty, their ability to understand the utterances and then reconstruct them will vary according to their overall speaking proficiency.

With some caution, Bley-Vroman and Chaudron (1994) stated,

> We regard it as premature to view elicited imitation as a proven method for inferring learning competence, because a considerable amount of research needs to be conducted to understand how performance under imitation conditions compares with other methods and with learners' underlying knowledge. (p. 245)

They further stated, “The more you know of a foreign language the better you can imitate the sentences of the language. Thus, EI is a reasonable measure of global proficiency (p. 247).” In essence, EI can produce a quick indication of a person's overall language proficiency.

EI in second language testing. Elicited imitation has been used mainly within three areas: child language research, neuropsychological research and second language research (Vinther, 2002). For second language research uses, test-takers listen to and repeat, to the best of their ability, utterances of varying lengths and complexities in the language being acquired (Graham et al., 2008a). The premise is that a person's ability to accurately repeat is dependent upon language proficiency. A low proficiency test-taker's ability to accurately repeat sentences will diminish as the utterances get longer and more complex.

Using112 students learning French, Naiman (1974) developed an EI test and compared it with comprehension and production tests. His results showed a strong correlation between the EI test scores and the scores on other tests.

Henning (1983) assessed 143 adult Egyptian learners of English as a foreign language using three oral proficiency testing methods (a) EI, (b) oral interviews, and (c) sentence completion. Similarly, five components under each method (raw score, fluency, pronunciation, grammar, and combined fluency-pronunciation-grammar ratings) were analyzed separately and in tandem. Multicomponent-multimethod convergent and discriminant validities were determined. Stepwise multiple regression was computed using FSI-like interview scores as the dependent variable. Rasch latent trait calibration and tests of fit validity were also computed for imitation and completion tests. Researchers compared the three oral testing methods across all components for all empirical validity indexes and ranked them. The EI test ranked first followed by the interview and the completion method.

Additionally, Radloff (1991) and other researchers from the Summer Institute of Linguistics (SIL) used the EI as an assessment of oral proficiency in Pakistan and compared it with OPI ratings. They also found EI to be reliable and correlated with OPI ratings.

More recently, Erlam (2006) tested EI with 20 native English speakers and 95 English as second language learners. The design of her test differed from many EI tests. She used some ungrammatical sentences to see if test-takers would use their implicit language knowledge and correct the ungrammatical sentences. The results show that native speakers were able to correctly repeat 97% of the grammatical items; additionally, they corrected 91% of the ungrammatical items. The second language learners were able to repeat 61% of the grammatical items and they corrected 35% of the ungrammatical ones. She then correlated the scores for repeating grammatical sentences with the scores for correcting ungrammatical sentences and found a significant positive correlation for all participants.

Additionally, Erlam (2006) compared the test-takers' EI performance with their performance on an oral narrative task and the International English Language Testing System (IELTS) speaking and listening test (the scores for grammatical and ungrammatical items were combined). Results showed a significant correlation between the second language learners' overall scores on the EI task, the oral narrative task, and both the IELTS speaking and listening tests. She concluded that the EI test is a likely measure of implicit language knowledge.

BYU PSST group. Most recently, the Pedagogical Software and Speech Technology (PSST) research group in the BYU Department of Linguistics developed, tested and validated EI tests in several languages. In the first of their studies (Graham et al., 2008a), researchers created a 60-item English EI test and administered it to 156 adult ESL learners. The subjects were also given four additional speaking tests. These included an informal 15-minute placement interview, a 30-minute simulated computer-administered oral proficiency test English Certification Test (ECT), a 30-minute computer-elicited oral level achievement test (LAT), and an Oral Proficiency Interview (OPI). Their results indicate that correlations between the EI scores and other measures are on the same order as intercorrelations among the other four more conventional methods of measuring oral language proficiency. For example, the EI correlates with the OPI as well as or better than the informal placement interview and the two computerized speaking tests, which require much more training and time to administer and score. They concluded that overall comparisons between EI scores and scores on other measures of oral language proficiency were very promising.

The PSST group has also created and validated French, Japanese and Spanish EI language proficiency tests (Graham et al., forthcoming; Matsushita, 2011; Millard, 2011). All three of these EI proficiency tests showed promising results indicating that EI can measure global language proficiency accurately and reliably.

Additionally, the BYU PSST group has published several articles pertaining to elicited imitation testing. These include (1) the role of lexical choice in elicited imitation items (Graham et al., 2008b), (2) the use of automatic speech recognition (ASR) scoring (Graham et al., 2008a), (3) selecting EI items (Christensen et al., 2010), (4) factors that contribute to item difficulty (Hendrickson et al., 2010), and (5) morphological features of second language acquisition (Weitze et al., 2011).

Design. Tomita and Jessop (2009) gave a list of criteria that should be considered in the development of an EI instrument:

1. Stimulus sentences should exceed participants' working memory capacity.
2. Target structures (features that are being evaluated) should be embedded in the middle of the stimulus sentences.
3. Sentences must ensure that the participant is attending to meaning rather than form.
4. The participants' performance must not be greatly influenced by the sentence's linguistic complexity or difficulty.
5. Stimulus sentences should not be too easy or too difficult.
6. Instructions need to be simple and clear.

7. The testing environment should be comparable for all test takers.
8. The materials need to be equally appropriate for all participants.
9. Scoring must accurately reflect the participants' proficiency. Detailed scoring procedures must be provided for the raters.
10. Two or more trained raters should score the data and have high interrater reliability or one researcher should score with a relatively long time interval between ratings.

Many of these standards involve considerable work in selecting appropriate items for the test. There are several ways to develop or select sentences for an EI test: (a) construct sentences that include features that need to be investigated, (b) administer another proficiency measure, like the OPI, and use utterances from this test as EI stimuli, and (c) extract naturally occurring sentences from a corpus of natural language (Millard, 2011). Some studies have found that constructed sentences are often unnatural and awkward. This can limit their effectiveness (Christensen et al., 2010). Using naturally occurring authentic sentences improved correlations and better distinguished higher level speakers (Christensen et al., 2010; Matsushita, 2011).

To aid in constructing and annotating English EI test items from authentic materials, researchers developed an automatic sentence analysis tool (Christensen et al., 2010). They brought together several available resources into one tool. The tool drew data from single sentence input by the user or from a corpus. Then it used several online tools to parse and annotate relevant features of each sentence. The tool enabled researchers to specify desired grammatical features, relative position in the sentence (at the beginning or end), lexical density of the item, morphological complexity and sentence length. Therefore, researchers were able to select authentic sentences that have all of the desired linguistic features, without having to construct the sentences themselves.

It is important to note that the syllable length ceiling is different for each language. Native speakers of English usually break down (cannot repeat back) at about 22 syllables, whereas native Spanish speakers can go up to 32 syllables. Therefore, it is important to test the ceiling effect for each language in advanced (R. Graham, personal email communication, August, 28 2012).

Administration. Test administration is critical to the achievement of valid and reliable scores when using EI tests. Several methods have been used in administering the test. Initially, sentences were delivered directly from the researcher to the test-taker. The responses were recorded either by hand or by tape recorders (Erlam, 2006). The current practice is to deliver the sentences online, record the responses using computer software and save them as *.wav* files.

As previously mentioned, it is very important that instructions are clear and simple so that the test-takers know exactly what to do during the test. It is also vital that the stimulus prompts are high quality recordings that are easy to understand (natural speech rate, sufficient volume, etc.). In previous BYU testing, the reliability of the proficiency scores was greatly affected by problems in sound volume and rate of speech (R. Graham, personal email communication, August 20, 2012).

Research continues with regard to issues concerning the best delivery methods. Some of these issues include using male or female voices for the prompt, the speed of the delivery, allowing users to control item advancement, and the length of pause between items. One current researcher, who has tried several methods of delivery, suggests that it is best to keep things consistent. The sentences should advance automatically with a three to four second pause in between each item (R. Graham, personal email communication, August 20, 2012).

Scoring. There are two main methods for scoring elicited imitation items; hand scoring and automatic scoring that uses speech recognition software. For hand scoring, some researchers have used methods where a subjective score is given according to meeting certain criteria (Ortega, 2000). Another example is Keller-Cohen (1981) who used a 1 to 7 scale continuum (1= no repetition and 7= perfect imitation). These methods are considered less reliable because they require complex subjective grading procedures.

Other researchers have used scoring methods that look for correct imitations of specific grammatical features. In one study, the correct or incorrect imitation of the specific feature under investigation rendered a binary score of 1 or 0 (Erlam, 2006). In another study, Müller (2010) used weighting procedures with the features deemed to be the most important.

To make scoring more objective, Chaudron et al. (2005) introduced a scoring method where raters counted mispronounced or missing syllables in each sentences and gave a score ranging from four points (for a perfect repetition) to zero points (for utterances with four or more errors). To improve upon this method, Graham (2006) implemented a binary scoring method: one point for each correctly pronounced syllable. Then, each sentence would calculate a total score for the proportion of syllables pronounced correctly. Finally, there would be a total score for the proportion of syllables pronounced correctly for the entire test.

All of these methods mentioned describe human hand scoring. Even though methods have improved to become more objective, raters still need training with issues they encounter when rating. EI researchers have suggested the following guidelines (R. Graham, personal email communication, August 20, 2012):

1. If the test-taker inserts a word, it is not counted against them.
2. If the test-taker transposes two words, give one point for one word but not both.

3. If the pronunciation is so far off that the syllable would not be recognized, do not give credit.
4. If an utterance is cut off, the raters can only give credit for what they hear.

Automatic speech recognition (ASR) is an emerging technology that uses software to transcribe spoken language. It is a complex task combining physics, engineering, mathematics, statistics and linguistics. Carnegie Mellon University has developed and offered Sphinx as an open source product. Sphinx requires an acoustic model, a language model and a pronunciation dictionary. For several languages, including Spanish, there are existing models available (C. Kennington, personal email communication, August 19, 2012). Automatic speech recognition involves taking an input acoustic signal and sampling it at regular intervals. The samples are then analyzed for features that are salient for downstream processing (Graham et al., 2008a). Developing an ASR involves an iterative refinement process trying out different recognizer parameters, grammar and lexical specifications, and language models. In order to improve ASR scoring, developers can even create a unique language model for each individual stimulus. With this, the recognizer is able to identify what the test-taker said and compare it against the expected utterance.

Researchers have identified a few issues that need to be considered when using ASR for EI tests (Graham et al., 2008a). First, ASR is an emerging technology and advancements continue to be made. Second, automating the task of rating involves a nontrivial integration with already complex systems. Third, the test-takers are non-native speakers with varying degrees of their first language accents, whereas ASR models are generally tuned and trained for recognition of native speakers. Fourth, there is a granularity mismatch in the data since EI scores are done at the syllable level whereas ASR scores are computed at the word level.

On the other hand, these same researchers have identified several considerations that make ASR use with EI tests convincing (Graham et al., 2008a):

1. Since humans can score EI following strict scoring criteria, it is reasonable to expect that one could automate the task.
2. The expected input for any given test sentence is already known, so the ASR task is much more constrained.
3. The ASR task can be developed with open-source technology in languages where the resources exit.
4. There is a sizable potential economic benefit if the test can be delivered on a large scale, short turnaround time and at low cost when compared to human scoring.
5. The procedure can be applied to score learners of other languages, provided ASR models are available for those languages.

Despite the complexities with developing ASR scoring systems with EI, significant progress has been made and continues to be made. For example, Graham et al. (2008a) reported that they were able to achieve r = 0.90 correlation with the ASR and the hand scoring of English EI. Additionally, Moulton (2012) reported r = 0.82 correlation with the ASR and the hand scoring. For Spanish, Graham, (forthcoming) reports correlations ranging from r = 0.85 to r = 0.88 between ASR and hand scoring of Spanish EI.

The research possibilities for ASR are quite numerous. ASR can provide additional information regarding recognized utterances. Examples include silent pauses, syllabic timing (rhythm), speech chunks, disfluencies, pitch, phoneme lengths, and utterance durations (Graham et al., forthcoming).

Statistical Analysis used to develop EI measures. Elicited imitation uses several methods of analysis. First, simple correlations are used to validate the EI with other external measures as well as compare hand scoring with ASR scoring. Second, item response theory is used to analyze the EI items in order to identify the best discriminating items. Lastly, some recent research has used regression to determine the linguistic features that contribute to item difficulty.

The most common statistical procedure, which is used to validate elicited imitation tests, is the use of correlations. The English EI test is often compared to other external measures, such as the OPI (Graham, 2008a). Overall correlations of external measures with the EI are fairly strong. In one recent study, Bernstein et al. (2010) found that external tests correlate with the EI between r = 0.75 and r = 0.85.

At the Missionary Training Center, the results of the English EI test were compared to the Language Speaking Assessment (Moulton, 2012). In this study, the correlation between the LSA and the hand-scored EI test was r = 0.83, while the correlation between the LSA and the ASR was r = 0.89. Another use of correlation includes comparing hand scoring results with ASR results. For this recent MTC study, the hand scoring and ASR score correlated at r = 0.86 (Moulton, 2012).

There are two popular methods for analyzing and improving tests: Classical Test Theory (CTT) and Item Response Theory (IRT). CTT uses several statistics: (a) item difficulty index (the proportion of examinees answering the item correctly), (b) item discrimination index (the extent to which an item differentiates between examinees), (c) reliability coefficient, and (d) standard error measurements. There are four limitations of CTT that IRT solves.

First, the traditional statistical indicators listed above, are group dependent. In other words, the size of these statistics varies depending on the group who took the test. Second, the scores obtained by the examinees are test-dependent: scores are not directly comparable to the scores of examinees who responded to other forms of the test. Third, CTT assumes that the error variance is the same for examinees across all levels of ability. It does not provide a way of estimating differences in measurement error for examinees at varying levels of the trait or ability being measured. The standard error of measurement based on CTT is a group statistic that describes the average amount of measurement error in the scores of examinees at varying levels of ability. Lastly, the CTT concept of reliability is defined in terms of “parallel” test forms, but in practice it is difficult to obtain or construct alternative forms that are strictly parallel (Sudweeks, 2011).

Item Response Theory (IRT). IRT is the best method to use when constructing and/or improving tests because it does not have the limitations of CTT. IRT is a family of statistical modeling procedures used to analyze people’s responses to individual items in a test or other assessment procedures in order to estimate the degree to which individuals possess the latent trait measured by a particular test or scale IRT also predicts how the probability of selecting a particular option varies as a function of the person’s trait level (Sudweeks, 2011).

One advantage of IRT is that both the item difficulty calibrations and the person ability measures are calculated on the same scale or metric. Consequently, once a researcher has computed estimates of the difficulty parameters for the various items and the “ability” (or trait level) of each examinee, these estimates can be graphically displayed on the scale representing the latent trait collectively measured by that set of items. The latent trait scale usually ranges between +4 and –4. The zero point on the scale represents an item of average difficulty. Items that have difficulty calibrations below zero are easier, while items with difficulty calibrations above zero are more difficult. Similarly, persons who have large positive trait levels estimates are presumed to have more of the trait than persons who have smaller trait level estimates (Sudweeks, 2011).

IRT Partial Credit Model. In the IRT family, the most common models are used for dichotomously scored items (1=correct, 0=incorrect). As an extension to the dichotomous models, there are models used to score polytomous items (more than two possible responses). Polytomous models are used for test items for which successively higher integer scores are intended to indicate increasing levels of competence or attainment. Past elicited imitation projects have used the Rating Scale Model (RSM). For this project, the Partial Credit Model (PCM) was used. The PCM was developed for use in situations where assessment instruments contain items that represent ratings of the degree of quality, frequency, amount and where different items include either varying number or varying kinds of response categories (Sudweeks, 2011).

The Rating Scales Model and the Partial Credit Model function quite similarly and produce similar statistical results. The major difference between the two models lies in the number and function of response categories. With PCM all items are assumed to have the same discriminating power, but the items may have different number of response categories or categories that function differently. With the RSM all items have a common set of response options that are assumed to function in the same manner across all items.

Item response theory helps researchers identify the best discriminating items. Once these items are identified, the test can be shortened and retested (Graham, 2008a). Specifically, recent research has shown that the Rasch Rating Scale Model worked the best when analyzing items (Graham, 2008a). To use the rating scales model, overall test score percentages are divided into categories. For example, five categories may use: 0% = 1, 1%-34% = 2, 35%-64% = 3, 65%-99% = 4, 100% = 5. Once the categories have been established, the Rasch Rating Scale Model analyzes the items and produces valuable item information which is used to identify the best items.

Multiple regression. Recently researchers used multiple linear regression analysis to see what factors have the most impact on item difficulty in English (Hendrickson et al., 2010). The authors used item difficulty scores from previously administered tests with IRT. They then tagged each sentence for syntactic, lexical, and morphological features that could affect the difficulty of an item. Their results indicated that overall syllable length contributes the most to item difficulty. Further analysis looked at groups of sentences with the same syllable length. They found that for some syllable lengths, a few specific grammatical features contributed to item difficulty. Preliminary regression analysis looking at the data from the BYU version of the Spanish EI test found that sentence length - as measured by the number of syllables - was the only contributing factor.

In summary, the literature argues that EI tests are valid and reliable measures of global language proficiency. However, the methods and process for developing, administering and scoring tests vary and some are better than others.

Chapter 3: Method for Developing Spanish EI Test

This chapter outlines the process for developing and administering a specialized Spanish EI test for use in the MTC, Provo, Utah. The process of creating and refining an EI test is multifaceted. First, items/sentences need to be carefully selected. Then, the sentences need to be recorded and placed in a delivery module. Next, the sentences need to be tested with a significant number of language learners. After that, the sentences need to be scored or rated. Once the sentences are scored, they are then statistically analyzed to find the best performing items. Lastly, the best performing items are tested, scored, and analyzed to make sure they are functioning properly as a group.

Development of the MTC Spanish EI instrument

The development of an EI test starts with selecting items. The items are then tested and analyzed. The best performing items are used in the final version of the test.

Selection of items. The MTC teaches a specialized language consisting of religious-related vocabulary found in a teaching context as well as missionary specific tasks (e.g., becoming acquainted with someone, asking questions, making invitations, setting appointments). The MTC Spanish EI test needed sentences that fit the context of the language being assessed. As indicated in the literature review, research has shown that using authentic naturally-occurring sentences improves correlations and better distinguishes higher-level speakers because the sentences are more natural instead of artificially constructed. Other researchers have used corpus-based item annotation tools to help select items from established texts (Miller, 2011). No such tools were available in Spanish at the time of this project.

For these reasons, sentences for the MTC Spanish EI were selected from two established LDS missionary training texts: *Preach My Gospel* and *True to the Faith.* The task sentences were selected from speech samples from the Language Speaking Assessment (LSA) of native speakers performing missionary tasks. Sentence selection was based on sentence length (variety of sentences of varying lengths) with some attention to vocabulary and grammatical difficulty (variety of lexical and grammatical difficulty). For example, sentences were grouped by their sentence length and then researcher made sure that each group of sentences contained examples of easy (present tense) and difficult grammar (past tense, past subjunctive).

Once a large pool (approximately 150) of potential sentences was identified, each sentence was analyzed by an online program that separated the words into syllables and made it easy to accurately count the number of syllables in each word/sentence (e.g. “Mi her-ma-no es me-nor que yo.” = 9 syllables)[4]. Once the sentences were coded according to their syllable length, they were sorted from shortest to longest. Sentences were then organized into seven categories of sentence length (1) 7-10 syllables, (2) 11-14 syllables, (3) 15-18 syllables, (4) 19-22 syllables, (5) 23-26 syllables, (6) 27-30 syllables, (7) 31-34 syllables. The goal for the first phase was to create an item pool consisting of 15 potential sentences for each sentence length category for a total of 105 sentences (15 sentences in each of the 7 categories = 105 total sentences). At this point, a simple analysis was conducted to compare potential sentences to compile a good representation and variety of vocabulary and grammar. These 105 sentences were then randomly assigned to one of three tests (forms A, B and C). Each test consisted of 5 items in each of the seven categories (see Table 1).

[4] http://www.respublicae.net/lengua/silabas/index.php

Table 1

Testing design

	Form A	Form B	Form C
7-10 syllables	5 items	5 items	5 items
11-14 syllables	5 items	5 items	5 items
15-18 syllables	5 items	5 items	5 items
19-22 syllables	5 items	5 items	5 items
23-26 syllables	5 items	5 items	5 items
27-30 syllables	5 items	5 items	5 items
31-34 syllables	5 items	5 items	5 items
Total:	35 items	35 items	35 items

Selection of an elicitor. Once the 105 potential sentences were identified, they were audio recorded. Special consideration was taken in selecting the elicitor. Some EI researchers purport that because male voices are lower, they are easier to hear and understand (T. Cox, personal communication, May 7, 2012). In addition to this, the elicitor needed to be a native Spanish-speaker, who could speak “standard” or “neutral” Spanish pronunciation. In order to test the elicitor’s standard pronunciation, the potential elicitor was asked to record several Spanish pangrams (i.e., sentences which use every letter of the alphabet at least once). Several native speakers, from varying countries, listened to the recordings and were asked if they believed the pronunciation to be standard or neutral. All indicated that the elicitor’s pronunciation was standard. Additionally, a native Spanish-speaking professor listened to the recordings and reported that speaker’s accent was acceptable.

The sentences were then recorded using high quality studio equipment by one native, male, Spanish-speaker using neutral pronunciation. He was instructed to speak methodically and clearly so that each word could be understood distinctly. He practiced each item several times. After the sentences were recorded, the audio files were put into the EI test delivery module built by MTC programmers.

In the past, researchers have tested several ways of administering the test, including giving the test-takers control to advance to the next item when they were ready. The researchers suggested that the best way was to have the sentences advance automatically with a few second delay in between each item (R. Graham, personal email communication, August 20, 2012). Therefore, the delivery module was built to advance the sentences automatically. Additionally, during the initial testing of the EI delivery, a question arose about how much time to allow the participant to record their response. At first it was decided to take the amount of time it took the elicitor to say the sentence and add two seconds. After some testing, the decision was made to take the elicitor's time and add four seconds.

Testing Phases

There are two phases to testing the EI instrument. The first phase tested a large pool of items with a large population. The items were then analyzed to select the best performing items. The second phase took the best performing items from Phase I and again tested and analyzed them to make sure that they were performing well as a group.

Phase I. The first phase focused on testing a large pool of 105 items. Previous researchers used a sample of about 70 participants to test an English EI instrument (Graham, 2006). Therefore, a large sample size is needed to test a large pool of items.

Participants. As described previously, missionaries at the MTC learning Spanish are assigned to beginning, intermediate or advanced level classrooms. Beginning and intermediate level missionaries, at the time of this study, were trained at the MTC for nine weeks while advanced speaking missionaries stayed for three weeks. Class sizes in this study ranged from three to twelve students with an average size of eight.

Since missionaries in the beginning group enter the MTC every week, the subpopulation of the beginning group consisted of classrooms which had been learning Spanish ranging from two to nine weeks. The advanced and intermediate subpopulation at the time of testing had four classrooms each. All of the advanced and intermediate classrooms were used in the sample and a stratified random sample was used to select classrooms in the beginning subpopulation (see Table 2). In addition to the 227 missionaries, four native speakers participated for a grand total of 231 participants.

Table 2

Sample for Phase 1

	Week at MTC	Number of Classrooms	Total number of participants
Beginning	2	3	172
	3	2	
	4	3	
	5	3	
	6	3	
	7	3	
	8	3	
	9	3	
Intermediate	2	1	27
	4	1	
	6	1	
	8	1	
Advanced	1	1	28
	2	2	
	3	1	
Native speakers			4
Total		31	231

Testing. To test the items, a researcher went to the classrooms, solicited the participants' participation and set up an appointment to administer the test in a computer lab. Before the administration of the test, a researcher explained the purpose of the test and asked the participants if they were willing to volunteer and then had them sign consent forms.

For Phase I, the researcher randomly assigned each participant in a class to take either test Form A, B, or C. In other words, if a class had nine members, three participants were randomly assigned Test A, three to Test B, and three to Test C. Each participant was assigned a different form of the test than the participants on either side of them in order to avoid any unintended influence from participants sitting next to them.

The initial goal for Phase I was to have 70 participants take each form of the test for a total of 210 participants. In anticipation of unforeseen problems or losing participants, the researchers oversampled (231). Some participants did not come to the testing appointments with their classes (sickness, other commitments) and some computer problems resulted in the loss of tests. However, the initial goal was met and in the end 70 participants of varying proficiency took Form A, 70 took Form B, and 81 took Form C. All four native speakers are included in these totals and each native speaker completed all three forms of the test.

Phase II. The purpose of Phase II was retesting the best performing items from Phase I. After testing and analysis of the 105 items, the best 43 items were identified (test form D) and those items were tested again. Because there were fewer items to test, Phase II had a smaller sample.

Participants. The second phase used all of the intermediate and advanced missionaries in the MTC at that time, along with a stratified random sample of the beginning classes. Phase II participants included three advanced classrooms, four intermediate classrooms, and five beginning classrooms for a total of 104 participants (see Table 3). The proportion of subpopulation participants in Phase II was different than the proportion of the subpopulations in Phase I. The reason for this difference will be explained in the analysis and results section.

Table 3

Sample for Phase II

	Week at MTC	Number of Classrooms	Total number of participants
Beginning	3	1	47
	4	1	
	5	1	
	7	1	
	8	1	
Intermediate	3	1	34
	4	1	
	7	1	
	8	1	
Advanced	2	3	23
Total		12	104

Testing. In Phase II, all participants took the MTC Language Speaking Assessment (LSA) in addition to the elicited imitation test (Form D). In contrast to the Phase I participants, the Phase II participants were all taking the same test. To avoid participants influencing each other during the elicited imitation test, every other participant was assigned to start with either the EI test or the LSA. Therefore, participants sitting next to each other were not taking the same test at the same time. The initial goal for Phase II was to have 100 participants take Form D of the test, in the end a total of 95 participants took Form D, which was deemed an adequate sample.

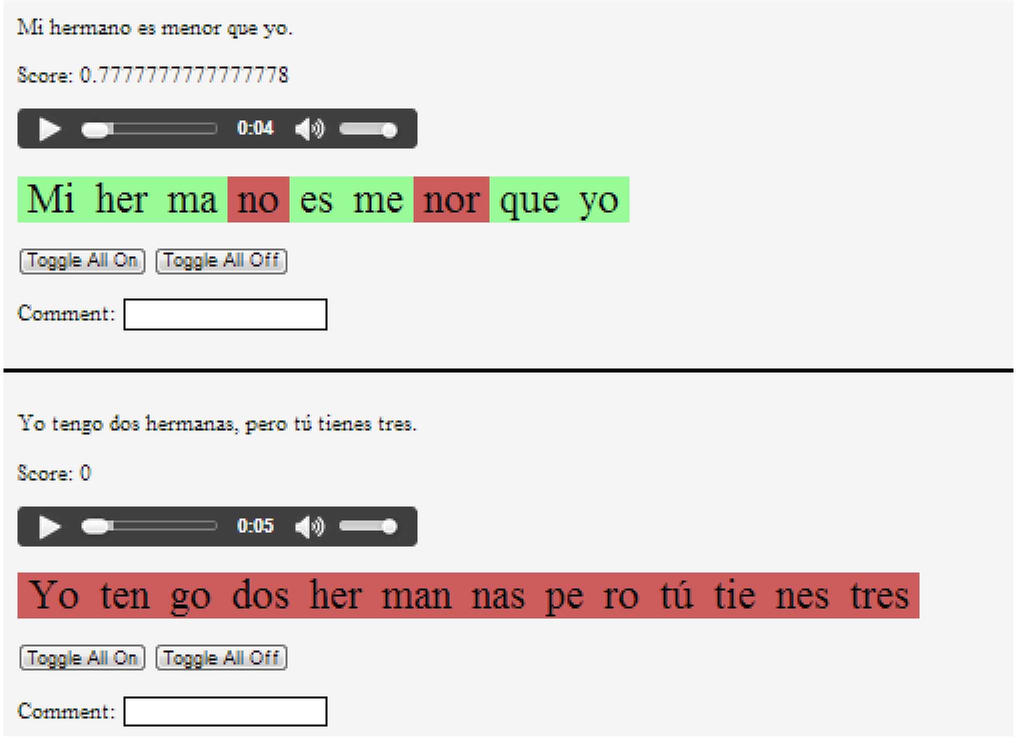
Test administration. All participants used computers with headsets and microphones. After an initial login page and a simple exercise to make sure the headsets and microphones were working properly, the following instructions were presented on the computer screen: *For this test, you will hear a sentence in Spanish followed by a beep. After you hear the beep, repeat the sentence back as accurately as you can. After you repeat back the sentence there will be a few seconds pause and the next sentence will start automatically. Click "Begin Test" when you are ready to start.*

It took about seven minutes for Phase I participants to complete a test with 35 items. As mentioned above, Phase II participants took two oral language proficiency assessments, the EI test and the LSA. Both tests took about 10-15 minutes each to complete.

Scoring EI Tests For Both Phases

Elicited imitation tests were scored using two methods: (a) hand rating by a trained rater and (b) automatic speech recognition software (ASR). Hand rating was done in this study first because it is considered the most reliable until the ASR is developed and correlates highly with the hand scores.

Hand rating. For hand scoring, each item was displayed in a web-based rating interface developed and built by MTC programmers. The rater interface displayed the target sentence, a score feature, the audio file and the sentence broken down by syllables (see figure1). The human rater played the recorded audio file and clicked on (or highlighted) any syllables that the participant repeated accurately. Participants received either a 1 or 0 score for each syllable in each item. Each item received a sentence accuracy rating which was the proportion of the syllables repeated correctly in a sentence (between 0.00 and 1.00). As syllables were marked correctly, the score was automatically calculated. The “proportion correct scores” for all the items was averaged together for one overall score (between 0.00 and 1.00) for each participant.



Mi hermano es menor que yo.

Score: 0.7777777777777778

Mi her ma no es me nor que yo

Comment:

Yo tengo dos hermanas, pero tú tienes tres.

Score: 0

Yo ten go dos her man nas pe ro tú tie nes tres

Comment:

Figure 1. Example of rating tool interface.

Hand rating was labor intensive. For this project, 11,820 items were rated. To help with the task, in addition to the primary researcher, six Spanish speakers were trained how to rate. After helping the raters become acquainted with the rating tool, they were instructed on the following rating guidelines.

1. If the test-taker inserts a word, it is not counted against them.
2. If the test-taker transposes two words, give points for one word but not both.
3. If the pronunciation is so far off that the syllable would not be recognized, do not give credit.
4. If an utterance is cut off, the raters can only give credit for what is heard.

Next, all seven raters rated two tests, and their item ratings were compared. Simple correlation analysis results showed very high correlations between the seven raters *r* = 0.98 to 0.99.

ASR scoring. The ASR technology was based on the language model used at BYU. This model utilized the Sphinx ASR engine (Lee, 1989). Sphinx used an acoustic model, a language model, and a pronunciation dictionary. An existing language model for Spanish was downloaded from http://www.voxforge.org/home (C. Kennington, personal email communication, August, 29, 2012). The ASR generated overall proficiency scores for each subject in the form of proportion correct (0.00-1.00).

Preparing the data for analysis. In Phase I of this project there were three tests (A, B, and C). All three tests measured the same construct and had the same rating system. The researcher in this project wanted to assess whether or not response categories in EI tests had the same number of response options and whether or not the response categories functioned differently. Therefore, this project used the IRT Partial Credit Model. The IRT model was robust enough to analyze all three tests at the same time together. Therefore, even though the participants did not all take the same test (except for the native speakers who took all three tests), all three tests were analyzed together and all items (105) were measured and compared together. It was possible to analyze the three tests together because the native speakers took all three tests. For analysis, the data, needed to be organized into a rectangular matrix with one row for each person and one column for an ID number and a column for each item. Missing values were put in the cells where data was lacking. For example if participant 102 completed form A she had scores for those 35 items. In the cells for the tests that she didn't complete, a "period" was inserted to indicate a missing value. The following table illustrates (with arbitrary data) how the data were organized (see Table 4). Phase II data had a straightforward organization because it was one test and all participants completed all of the items.

Table 4

Data Analysis Organization

ID	Test A item 1	Test A item 2	Test A item 3	Test B item 1	Test B item 2	Test B item 3	Test C item 1	Test C item 2	Test C item 3
01	0.25	0.36	0.55	0.89	0.36	0.11	0.51	0.73	0.19
02	0.33	0.25	0.89	0.22	0.32	0.46	0.48	0.79	0.63
03	0.15	0.48	0.25	.	.	.	.	.	.
04	0.02	0.42	0.91	.	.	.	.	.	.
05	0.88	0.63	0.46	.	.	.	.	.	.
06	0.25	0.36	0.55	.	.	.	.	.	.
07	0.33	0.25	0.89	.	.	.	.	.	.
08	.	.	.	0.25	0.36	0.55	.	.	.
09	.	.	.	0.33	0.25	0.89	.	.	.
10	.	.	.	0.15	0.48	0.25	.	.	.
11	.	.	.	0.02	0.42	0.91	.	.	.
12	.	.	.	0.88	0.63	0.46	.	.	.
13	.	.	.	0.25	0.36	0.55	.	.	.
14	.	.	.	0.33	0.25	0.89	.	.	.
15	.	.	.	.	.	.	0.25	0.36	0.55
16	.	.	.	.	.	.	0.33	0.25	0.89
17	.	.	.	.	.	.	0.15	0.48	0.25
18	.	.	.	.	.	.	0.02	0.42	0.91
19	.	.	.	.	.	.	0.88	0.63	0.46
20	.	.	.	.	.	.	0.25	0.36	0.55
21	.	.	.	.	.	.	0.33	0.25	0.89

The raw scores for EI data are proportion scores for each item (between 0.00 and 1.00). In order to run the IRT analysis the item raw scores needed to be converted into categories. For example, a ten category scale was represented by converting the proportion raw scores into category scores (see Table 5). The conversion can easily be done by using this rounding function in Excel (=ROUND(10*number,0)).

Table 5

Raw Score Conversion Chart

Raw score	Category
0-.05	0
.06-.14	1
.15-.24	2
.25-.34	3
.35-.44	4
.45-.54	5
.55-.64	6
.65-.74	7
.75-.84	8
.85-.94	9
.95-1	10

The data was converted and saved as a "Formatted Text (Space Delimited)(*.prn)" file and read into *Winsteps and Facets Rasch Software* [5]. For the analysis procedures, the partial credit model was implemented with additional commands for point biserial correlations (ptbis=y) and discrimination (discrim=y) parameters.

[5] http://www.winsteps.com/index.htm

Chapter 4: Analysis Results

IRT produces several types of statistics. These statistics should be used in combination with each other in any attempt to make decisions about the item categories and items to keep or omit. These statistics include the category probability curve, the average measures (difficulty), the category fit statistics, estimated discrimination statistic and overall test reliability.

Category Probability Curves

The first analysis was to assess how the 10 item categories functioned by looking at the category probability curves. When the PCM is used, a separate graph is produced for each item. The graph should include one curve for each response option (category) in the corresponding item(s) (e.g. the raw scores were converted into 10 categories). These curves show the probability of selecting each response category for persons located at various points along the latent trait continuum. Ideally, the curves should be shaped like a series of hills with valleys in between them. Except for the lowest and highest categories, the hills should be approximately uniform in height. A flat curve indicates that very few persons were in the category represented by that curve. The presence of flat curves generally produces disordering and indicates that two or more adjacent categories may need to be combined into one category (Sudweeks, 2011).

Using the PC model, the category probability curves using ten categories showed that some of the categories were not used in many of the items and that the categories functioned differently with each item. This indicates that the categories should be collapsed. Ultimately, after several test iterations, the ten categories were collapsed into six categories (0-.24 = 1; .25-.44 = 2; .45-.64 = 3; .65-.84 = 4; .85-.95 = 5; .95-1 = 6). Collapsing categories can be done with extra commands in Winsteps or through find and replace commands in excel. Figure 2 shows the Category Probability Curve for Test B, Item 14 with six categories.

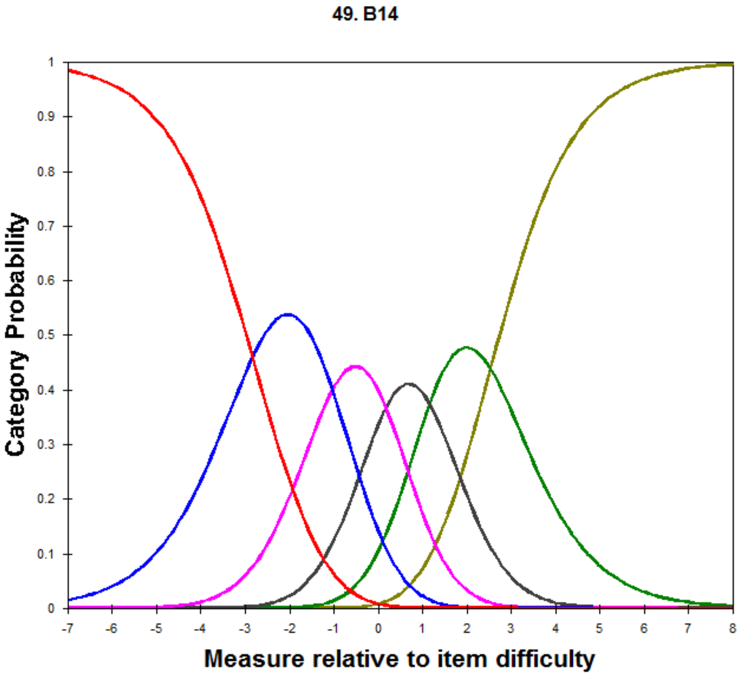


Figure 2. Category Probability Curve

Average Measures

The average measure score is the number reported for each category that describes the average of the estimated ability measures for all persons in the sample who achieved that category (averaged across all items). The average measure score is also considered the IRT difficulty index (Sudweeks, 2011). For example, if an item has a measure score of 3.75, that means that the estimated average ability measure for all persons in the sample who achieved that category was 3.75. As mentioned before, these scales ranges between +4 and – 4, therefore this would be a difficult item. For this project, the tests (Phase I and Phase II) had a good range of average measure statistics (+3.06 to -3.17).

Category Fit Statistics

Fit statistics are squared standardized residuals between what is observed and what would be expected. It is meant to indicate unexplained variation or "noise" with each item. Each item should have an ideal outfit mean square between 0.5 and 1.5. Outfit mean squares greater than the ideal indicates that the item has unexplained variation or noise (Sudweeks, 2011). The outfit mean square statistics for test forms A, B, and C, identified several items that had poor fit. These items were omitted. As might be expected, test form D did not contain any items with poor fit statistics, because poor items from test forms A, B and C had been eliminated.

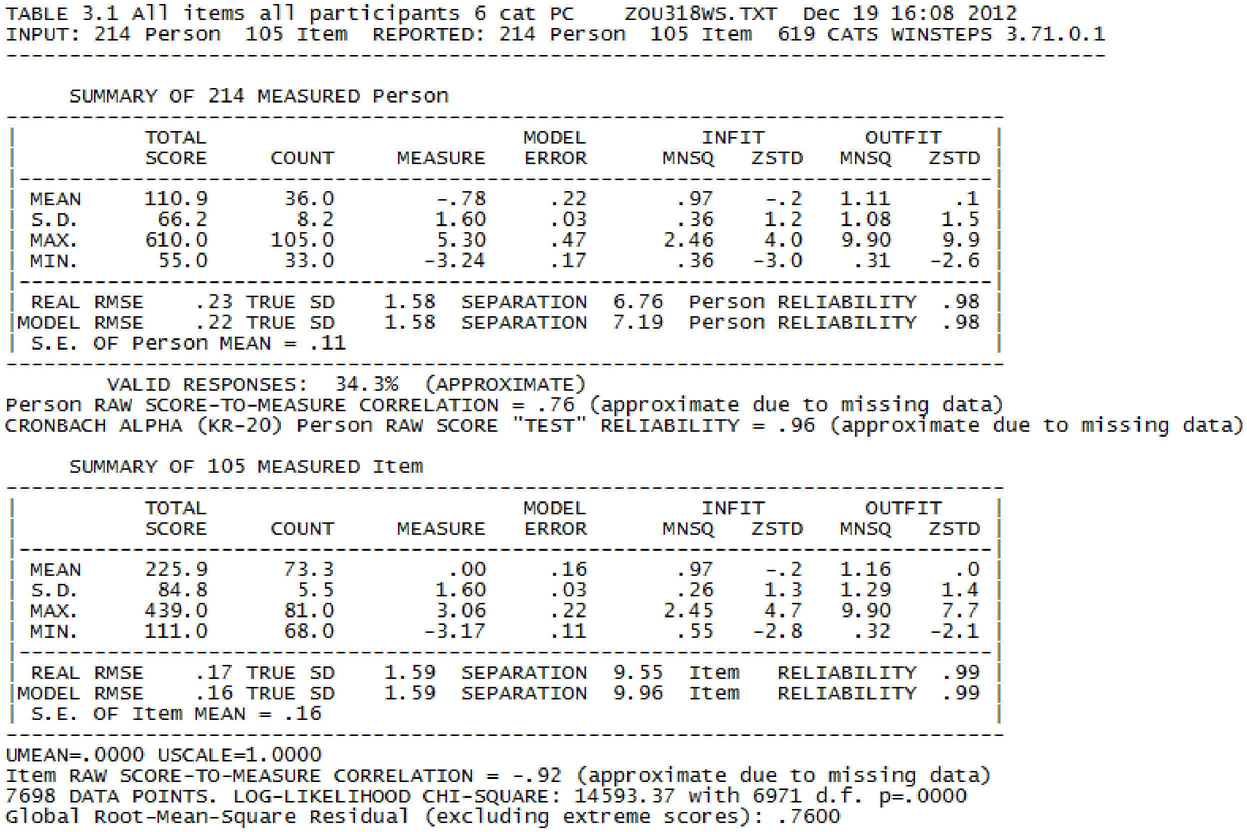
Estimated Discrimination

This statistic shows the estimate of the discriminating parameter for each item. The estimated discrimination ideally is as close to 1 as possible. Results for Phase I identified some items that had poor discrimination and those items were omitted. Again, as might be expected, analysis for Phase II showed no items with poor discrimination.

Overall Test Reliability

Winsteps produces two test reliability measures: person reliability measures and item reliability measures. The person reliability statistic produces a decimal number between 0 and 1.0 which is interpreted as the proportion of variability in the person measure that is explained by variability in the persons' true abilities. This reliability index is analogous to Cronbach's alpha computed for nonlinear, raw scores. However, the value of this IRT statistic is almost always somewhat lower (more conservative) than the value of Cronbach's alpha (Sudweeks, 2011). The person reliability measures for the MTC Spanish IE tests are very good at 0.98 for both Phase I and Phase II analysis (see figure 3 for Phase I).

Winsteps uses the variance ratio definition of reliability to compute an item reliability estimate (see figure 3). This estimates whether or not there is adequate range of item difficulty. CTT has no analog for this reliability estimate coefficient. High item reliability measures indicate that there is a high probability that items estimated with high measures actually do have higher measures than items estimated with low measures. The item reliability estimates for this project are very good at 0.99 and 0.98 for Phases I and II respectively. Phase I is slightly higher because more items were tested (105 vs. 43).



```
TABLE 3.1 All items all participants 6 cat PC     ZOU318WS.TXT  Dec 19 16:08 2012
INPUT: 214 Person  105 Item  REPORTED: 214 Person  105 Item  619 CATS WINSTEPS 3.71.0.1
--------------------------------------------------------------------------------

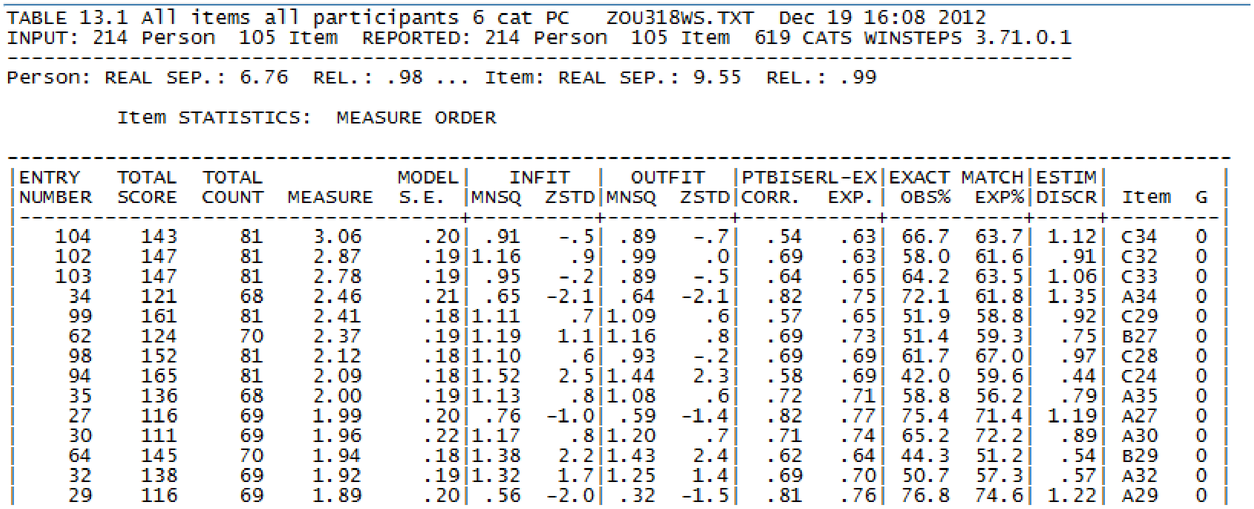
     SUMMARY OF 214 MEASURED Person
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT     |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN     110.9      36.0       -.78     .22        .97    -.2   1.11     .1 |
| S.D.      66.2       8.2       1.60     .03        .36    1.2   1.08    1.5 |
| MAX.     610.0     105.0       5.30     .47       2.46    4.0   9.90    9.9 |
| MIN.      55.0      33.0      -3.24     .17        .36   -3.0    .31   -2.6 |
|------------------------------------------------------------------------------|
| REAL RMSE    .23 TRUE SD    1.58  SEPARATION  6.76  Person RELIABILITY  .98 |
|MODEL RMSE    .22 TRUE SD    1.58  SEPARATION  7.19  Person RELIABILITY  .98 |
| S.E. OF Person MEAN = .11                                                    |
-------------------------------------------------------------------------------
        VALID RESPONSES:  34.3%  (APPROXIMATE)
Person RAW SCORE-TO-MEASURE CORRELATION = .76 (approximate due to missing data)
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .96 (approximate due to missing data)

     SUMMARY OF 105 MEASURED Item
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT     |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|------------------------------------------------------------------------------|
| MEAN     225.9      73.3        .00     .16        .97    -.2   1.16     .0 |
| S.D.      84.8       5.5       1.60     .03        .26    1.3   1.29    1.4 |
| MAX.     439.0      81.0       3.06     .22       2.45    4.7   9.90    7.7 |
| MIN.     111.0      68.0      -3.17     .11        .55   -2.8    .32   -2.1 |
|------------------------------------------------------------------------------|
| REAL RMSE    .17 TRUE SD    1.59  SEPARATION  9.55  Item   RELIABILITY  .99 |
|MODEL RMSE    .16 TRUE SD    1.59  SEPARATION  9.96  Item   RELIABILITY  .99 |
| S.E. OF Item MEAN = .16                                                      |
-------------------------------------------------------------------------------
UMEAN=.0000 USCALE=1.0000
Item RAW SCORE-TO-MEASURE CORRELATION = -.92 (approximate due to missing data)
7698 DATA POINTS. LOG-LIKELIHOOD CHI-SQUARE: 14593.37 with 6971 d.f. p=.0000
Global Root-Mean-Square Residual (excluding extreme scores): .7600
```

Figure 3. Phase I Person and Item Reliability Chart

Item Omission Decision Process

The goal of Phase I analysis was to reduce the 105 items to the best 43 items. The IRT statistics should be used in combination with each other when making decisions about which items to keep or omit. Figure 4 shows the measure statistics (difficulty), category fit statistics, and the estimated item discrimination parameter. The measure statistics (MEASURE) shows items from hardest to easiest and is found in the fourth column. The category fit statistics (OUTFIT MNSQ) is the eighth column and the estimated item discrimination parameter (ESTIM DISCR) is the fourteenth column.



```
TABLE 13.1 All items all participants 6 cat PC   ZOU318WS.TXT  Dec 19 16:08 2012
INPUT: 214 Person  105 Item  REPORTED: 214 Person  105 Item  619 CATS WINSTEPS 3.71.0.1
------------------------------------------------------------------------------------------
Person: REAL SEP.: 6.76  REL.: .98 ... Item: REAL SEP.: 9.55  REL.: .99

         Item STATISTICS:  MEASURE ORDER

----------------------------------------------------------------------------------------------------------
|ENTRY    TOTAL  TOTAL             MODEL|   INFIT    |  OUTFIT    |PTBISERL-EX|EXACT MATCH|ESTIM|          |
|NUMBER   SCORE  COUNT   MEASURE   S.E. |MNSQ   ZSTD|MNSQ   ZSTD|CORR.   EXP.| OBS%  EXP%|DISCR| Item   G |
|--------------------------------------+-----------+-----------+------------+-----------+-----+----------|
|   104    143     81     3.06      .20| .91    -.5| .89    -.7|  .54    .63| 66.7  63.7| 1.12| C34    0 |
|   102    147     81     2.87      .19|1.16     .9| .99     .0|  .69    .63| 58.0  61.6|  .91| C32    0 |
|   103    147     81     2.78      .19| .95    -.2| .89    -.5|  .64    .65| 64.2  63.5| 1.06| C33    0 |
|    34    121     68     2.46      .21| .65   -2.1| .64   -2.1|  .82    .75| 72.1  61.8| 1.35| A34    0 |
|    99    161     81     2.41      .18|1.11     .7|1.09     .6|  .57    .65| 51.9  58.8|  .92| C29    0 |
|    62    124     70     2.37      .19|1.19    1.1|1.16     .8|  .69    .73| 51.4  59.3|  .75| B27    0 |
|    98    152     81     2.12      .18|1.10     .6| .93    -.2|  .69    .69| 61.7  67.0|  .97| C28    0 |
|    94    165     81     2.09      .18|1.52    2.5|1.44    2.3|  .58    .69| 42.0  59.6|  .44| C24    0 |
|    35    136     68     2.00      .19|1.13     .8|1.08     .6|  .72    .71| 58.8  56.2|  .79| A35    0 |
|    27    116     69     1.99      .20| .76   -1.0| .59   -1.4|  .82    .77| 75.4  71.4| 1.19| A27    0 |
|    30    111     69     1.96      .22|1.17     .8|1.20     .7|  .71    .74| 65.2  72.2|  .89| A30    0 |
|    64    145     70     1.94      .18|1.38    2.2|1.43    2.4|  .62    .64| 44.3  51.2|  .54| B29    0 |
|    32    138     69     1.92      .19|1.32    1.7|1.25    1.4|  .69    .70| 50.7  57.3|  .57| A32    0 |
|    29    116     69     1.89      .20| .56   -2.0| .32   -1.5|  .81    .76| 76.8  74.6| 1.22| A29    0 |
```

Figure 4. Winsteps Table 13.1 Output

The first step was to divide the 105 items into seven groups according to their difficulty level (15 items). For example, the 15 easiest items ranged from -3.17 to -2.18. Then, analyzing the 15 items in each difficulty group, the items that had poor fit statistics (below 0.5 and above 1.5) were omitted. The next step was to cut out the items that had poor discrimination (below 0.75 and above 1.25). For example, the second easiest item had an OUTFIT MNSQ of 9.90 and an ESTIM DISCR of .61. This item was omitted because the outfit statistic is significantly higher than the ideal (0.5-1.5) and the estimated discrimination was distant to the ideal 1. Appendix A contains the complete Winsteps statistical output table with all 105 items showing how the items were grouped. The process was repeated with each group of items until the best six or seven items were found in each of the seven difficulty groups (total of 43 items). Most of the items in the Spanish EI test were within the ideal parameters, so the researcher narrowed the parameters even further (Outfit = 0.75-1.25; Discrimination = 0.85-1.15) .

Phase II used the best performing items from Phase I. These 43 items were tested again with 95 participants and the analysis was run again. Phase I analysis showed little variability in ability measures for participants assigned to the beginning level classes, even in cases where they had been at the MTC for longer periods of time (eight or nine weeks). Therefore, the sampling procedure for Phase II used a ratio where half of the participants were from beginning level courses (weeks 3-9) and the other half were from intermediate or advanced level classrooms.

The purpose of the Phase II IRT analysis of the 43 items was to make sure the items were functioning well together and they were performing well. The second analysis showed a good range of difficult and easy items and there were no items with poor fit or poor discrimination (See Appendix B for final version of the test). Ultimately the MTC Spanish EI test is a dynamic test with about 43 items (roughly seven items in seven difficulty categories). The computer randomly selects two to three items from each group for a total of 14-16 items. It takes about three minutes for participants to take the test.

ASR/Hand ratings Comparison

Developing a Spanish ASR engine is an iterative process that involves comparing had rating scores to ASR scores. An MTC developer found an open source acoustic model, a language model, and a pronunciation dictionary. The acoustic model is created by taking phoneme-aligned audio recordings and using software to create statistical representation of the sounds that make up each word. The language model tries to capture the syntactic properties of a language and predict the next word in a speech sequence (C. Kennington, personal email communication, January 19, 2013). The pronunciation dictionary

The MTC developer found two existing Spanish acoustic models produced by Voxforge [6] and another one produced by DFKI [7]. For the first test iteration MTC programmers used the Voxforge model. The ASR/hand rating correlation was very poor r = -0.31. The pronunciation dictionary and language model appeared to be correct as far as the programmer could see, so he

[6] http://www.voxforge.org/

[7] http://www.dfki.de/lt/

next tried the other acoustic model (DFKI). Correlations improved with the DFKI model, but were still poor *r* = 0.13.

The programmer felt that the next obvious step was to create a new unique acoustic model (MTC acoustic model). To do this he used the native speaker speech sample of the elicitor and then added “good” but non-native acoustic information (participants) into the model so it is less strict and allows less-than-perfect pronunciations. After testing, the programmer noticed that female participants were getting low ASR scores because the acoustic model was based on a male elicitor input. He identified the five highest ability female speakers and combined their samples with the male elicitor.

The MTC acoustic model worked significantly better than the open source models. At this point, the correlation between the MTC ASR and the hand rating scores was *r* = 0.80. The programmer felt that there are a few parameters he can still modify and hopefully the MTC ASR will be “working” well enough soon so that the ASR score will replace need for hand ratings. Other EI researchers have been able to achieve correlations above .90; this is the goal for the MTC Spanish EI. Because of the lack of Spanish resources and limited data availability, the programmer was able to assemble a respectable ASR is a short amount of time (C. Kennington, personal email communication January, 21 2013).

ASR scores are affected by participant’s pronunciation. Native speakers can have the tendency to speak quickly or slur across words. In these instances the ASR will give lower scores than hand ratings. Special measures will need to be taken to catch potential low scores with native and native-like speakers.

Item Difficulty Analysis

Once the best 43 items were identified, they were coded according to their grammatical difficulty. Grammatical difficulty was based on the ILR Handbook of Oral Interview Testing for Spanish (Lowe, 1982). The ILR Handbook identifies eight difficulty levels of Spanish grammar (0, 1, 1+, 2, 2+, 3, 3+ and 4). For example Level 1 = regular verbs (-ar, -er, -ir), radical changing verbs (*tener, poder, querer, costar*), reflexives (*llamarse*), irregulars (*poner, ir, haber, saber, hacer, ser, estar*). Also, for level 1 ratings the speaker should have a clear concept of agreement (gender, number, subject-verb); articles (definites: *el, la, los, las*; indefinites: *un, una, unos, unas*); contractions (*al, del*); adjectives (possessives 1st person: *mi, mis*, 2nd person: su*, sus*); most common qualifiers; adjectives and adverbs of quality (*mucho, poco, bastante, demasiado*); and idomaitc expressions of weather (*hacer*).

Some sentences had features that fell into several of the difficulty levels. For example, the sentence *El Libro de Mormón nos enseña la verdad* has level 1 grammar (*enseña* = present tense –ar verb) with a level 1+ (1.5) indirect pronoun (*nos*). In instances where the sentences contained features of more than one level, the rating fell in between the two categories (1.25).

After coding each sentence, hierarchical regression analysis using three blocks was used to regress the IRT difficulty score on length of each sentence as measured by the number of syllables and the grammatical features of each sentence. The regression tested for the main effect of length (block 1), the main effect of grammar (block 2) and the interaction of length and grammar (block 3) on IRT difficulty. Block 1 resulted in an R^2 of .813 which was significant ($F_{1, 41}$ = 178.75 p< .05). Adding block 2 and 3 did not significantly increase R^2. The final model 3 showed that only sentence length in the presence of grammatical difficulty and the interaction of sentence length and grammatical difficulty was significant. The results showed that sentence length significantly predicted item difficulty (*b* model 3= .074, *t*= 4.66, *p* < .001). Grammatical difficulty did not predict item difficulty (*b* model 3 = .140, *t* = .655, *p* = .516). Similarly, the interaction between grammar difficulty and sentence length did not predict item difficulty (*b* model 3= .000, *t* = -.060, *p* = .953).

These results seem quite conclusive; however there is still some question about what contributes to item difficulty. The raters noticed patterns while they were rating the items. They noticed that although grammar might not have influenced scores greatly, vocabulary undoubtedly did. If participants missed the conjugation of a verb, they would lose one or two points for the missed syllables. Conversely, if participants did not know the verb at all, they lost several syllable points. After a time raters could easily identify which words were contributing to the difficulty of the sentence. Therefore, the regression results may be spurious without the inclusion of lexical analysis.

Chapter 5: Summary and Conclusions

The goal of this project was to develop a valid, automated oral language proficiency measure for the Missionary Training Center. The measure needed to easy to administer and score. The MTC Spanish elicited imitation test fulfills this goal.

Summary

This research project had four research questions:

1. What does an MTC Spanish Elicited Imitation test consist of?
2. What is the process for creating an elicited imitation test?
3. What is the correlation between automatic speech recognition (ASR) scoring with hand scoring?
4. What makes an item difficult? What is the main effect of grammar? What is the main effect of sentence length? Is there an interaction between grammar and sentence length?

Nature of the MTC EI test. The MTC Spanish elicited imitation test of oral language proficiency is a practical, reliable measure of overall language proficiency. The MTC Spanish EI test is a combination of gospel teaching context sentences and missionary task sentences. The Spanish EI test will be used at the MTC for pre-MTC screening purpose (class placement), exit language proficiency measures, and pre/post test language gains analysis.

Process of developing an EI test. The process for developing an EI test includes six major steps. First, items/sentences need to be carefully selected. Second, the sentences need to be recorded and placed in a delivery module. Third, the sentences need to be tested with a significant number of language learners. Fourth, the sentences need to be scored or rated. Once the sentences are scored, they are then statistically analyzed, using IRT, to find the best performing items. Lastly, the best performing items are tested, scored, and analyzed to make sure they are functioning properly as a group.

Correlation between ASR and hand scoring. In the end, the open source acoustic models did not function well with the MTC Spanish EI test. An MTC developer made great headway in a short period of time in creating a unique MTC acoustic model. Work continues on improving the reliability of the MTC ASR engine. As of right now the ASR/hand score correlation is *r* = 0.80.

Nature of item difficulty. This project attempted to predict the linguistic features (grammar difficulty, number of syllables) that contributed to item difficulty. After coding each sentence, hierarchical regression analysis using three blocks was used to regress the IRT difficulty score on length of each sentence as measured by the number of syllables and the grammatical features of each sentence. The regression tested for the main effect of length (block 1), the main effect of grammar (block 2) and the interaction of length and grammar (block 3) on IRT difficulty. Block 1 resulted in an R^2 of .813 which was significant ($F_{1,41}$ = 178.75 p< .05). Adding block 2 and 3 did not significantly increase R^2. The final model 3 showed that only sentence length in the presence of grammatical difficulty and the interaction of sentence length and grammatical difficulty was significant. The results showed that sentence length significantly predicted item difficulty (*b* model 3= .074, *t*= 4.66, *p* < .001). Grammatical difficulty did not predict item difficulty (*b* model 3 = .140, *t* = .655, *p* = .516). Similarly, the interaction between grammar difficulty and sentence length did not predict item difficulty (*b* model 3= .000, *t* = -.060, *p* = .953).

Discussion and Implications. The Missionary Training Center has approximately 1000 missionaries at any given time, assigned to Spanish language classrooms. With recent age reduction announcements that number is expected to rise significantly. It is essential that the MTC has a valid and reliable way to measure missionaries' oral language proficiency for several reasons: (1) pre-MTC classroom level placement, (2) pre/post assessment measures for gains scores, (3) exit measures for institutional preparedness indicators, and (4) in-field assessment for longitudinal studies. Current MTC Spanish language assessments are time consuming and costly. The MTC Spanish elicited imitation test is a response to the MTC oral language proficiency assessment needs. Furthermore, the EI instrument design process outlined in this project be the blueprint for the development of future MTC EI tests in other languages. Some of the situations where the MTC could use the Spanish EI might be considered high stakes. The MTC needs to take test security into consideration for the implications for high stake situations.

The MTC Spanish EI takes approximately three minutes to complete at zero personnel cost to the MTC (once the ASR has been sufficiently calibrated) except for maintaining delivery and scoring modules. This is a significant improvement considering the MTC LSA that takes 15 minutes to administer and between 5-10 minutes to rate, coupled with the cost of training and paying raters. Not only has this project produced a valuable assessment tool for the MTC, this report will act as a blueprint for the development of future EI tests in other languages. In the next Phase of development, MTC administrators and researchers are planning on using this project as a template for creating EI tests in Portuguese, Russian and Japanese.

Broader implications beyond the MTC involve the academic conclusions that EI tests can be used to measure global language proficiency and that unique tests can be developed and validated for specific situations and corpora. Additionally, there are psycholinguist implications about how to measure Spanish grammar and lexical difficulty and how those levels of difficulty contribute to overall item difficulty.

There is still some question about what makes a Spanish EI item difficult. The statistical analysis showed that sentence length unquestionably predicts and contributes to item difficulty. Grammar difficulty and the interaction between grammar and sentence length were shown not to predict or contribute to item difficulty. Still, there are still significant questions on how lexical difficulty influences overall item difficulty. There is important evidence from raters about the patterns of breakdown involving the lexicon. For example, because one of the shortest sentences "*Todo lo bueno proviene de Dios*" has an uncommon verb "*proviene*," and most participants (except the most advanced) missed this verb. Even though this sentence only has 10 syllables (which would put it in the easiest category), it is number 11 out of 43 in difficulty. Another example is Item 14 "*El Espíritu Santo nos testificará que Jesucristo es nuestro Salvador y Redentor*". This item has 28 syllables, future tense and an indirect object pronoun (more difficult grammar), yet is easy. Many low ability participants received high scores on this item because of the common missionary vocabulary. The implication is that lexical difficulty is assumed to contribute to sentence difficulty and that the specialized missionary corpus vocabulary needs to be analyzed further. Also, researchers need to use more accurate ways to measure grammar difficulty before analysis can be done to determine the effect of grammar difficulty on item difficulty.

Limitations

There were several limitations with this research project. The first has to do with the participants. IRT experts assert that at least 200 participants are needed to conduct IRT analysis. This study used less than 100 participants for each form of the test. However, we know from the analysis that calibration occurred. If there had not been enough information to run the analysis the program would have stopped and reported an error.

Also, there were some problems with participants not trying or not taking the test seriously. After noticing this problem, the test administrators emphasized the importance of the test and how it would be used in the future. Attitudes improved after that, but some scores were affected by this issue. Additionally, some data were lost because of issues with technology and equipment furthermore some participants who were assigned to participate were unable to because of illness.

Another issue is with the scoring. The ASR engine is newly built and has not been calibrated. Calibration entails adjusting the software to produce scores that are close to the hand ratings. Calibration takes time and testing; therefore, it could not be accomplished in the timeframe of this project but, it will in the future. Additionally, the hand scores were not double rated. Previous EI research has shown that double rating correlations are very high. Therefore, it was not deemed necessary to conduct double ratings.

Additionally, the ILR Handbook of Oral Interview Testing for Spanish (Lowe, 1982) used in this study to assess grammar, is assumed to be a subjective estimation of grammar difficulty and might not accurately assess Spanish grammar difficulty (B. Bateman, personal communication, February 8, 2013). Better methods of grammar difficulty assessments need to be done before assumptions can be made about how grammar affects the difficulty of an item.

Recommendations for Future Research

There are three areas for future possible research (a) MTC, (b) linguistically, and (c) statistically.

MTC research. Future research at the MTC would include determining placement cut scores for intermediate and advanced level classrooms. Additionally, the MTC could validate the Spanish EI test with the Language Speaking Assessment (LSA). Because all participants in

Phase II took the LSA at the same time they took the Spanish EI test, the LSAs just need to be rated and the scores compared to the overall EI scores.

Linguistic research. As mentioned in the results and discussion sections pertaining to item difficulty, it is hypothesized that lexical difficulty will contribute to the variance of item difficulty. There is a Spanish Vocabulary Online Profiler which could help with this analysis[8]. This profiler identifies words that are (1) found in the most common one thousand words in Spanish, (2) the second thousand most common words, (3) the words found in the Spanish academic word list, and (4) those not found in the previous three. Individual words could be coded according to their difficulty (how common they are). Those codes could then be used to predict lexical difficulty on item difficultly. However, special consideration needs to be taken with regards to common missionary vocabulary. The Spanish VOP codes the word *profeta* as an academic word, arguably less common or more difficult however for missionaries this is a common, easy word.

Another linguistic feature study could analyze the syllable/word information. The MTC delivery module was programmed to record information about which syllables or words were rated correctly and incorrectly. This type of analysis would be able to identify, unquestionably, what linguistic features make a specific item difficult or what contributes to the difficulty of the entire test.

Statistical research. Because IRT is not person dependent it is simple and easy to cross validate different versions of a test that measures the same construct. For example, it would be interesting to cross validate test versions A, B, C and D or with outside measures such as the LSA or Oral Proficiency Interview.

[8] http://souffil.com/svop/index.php

In the end, it has been shown that elicited imitation tests are a valid and reliable measure of global language proficiency. EI tests can be developed for specific contexts and unique organizations. The process of developing and EI test involves identify a large pool of items, testing the items, analyzing the items and selecting the best performing items.

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Appendix A: Winsteps Output Phase I

```
TABLE 13.1 All items all participants 6 cat PC   ZOU318WS.TXT  Dec 19 16:08 2012
INPUT: 214 Person  105 Item  REPORTED: 214 Person  105 Item  619 CATS WINSTEPS 3.71.0.1
---------------------------------------------------------------------------------------
Person: REAL SEP.: 6.76  REL.: .98 ... Item: REAL SEP.: 9.55  REL.: .99

         Item STATISTICS:  MEASURE ORDER

-----------------------------------------------------------------------------------------------------
|ENTRY    TOTAL  TOTAL           MODEL|   INFIT  |  OUTFIT  |PTBISERL-EX|EXACT MATCH|ESTIM|         |
|NUMBER   SCORE  COUNT  MEASURE  S.E. |MNSQ  ZSTD|MNSQ  ZSTD|CORR.  EXP.| OBS%  EXP%|DISCR| Item  G |
|-------------------------------------+----------+----------+-----------+-----------+-----+---------|
|   104     143     81    3.06     .20| .91   -.5| .89   -.7|  .54   .63| 66.7  63.7| 1.12| C34   0 |
|   102     147     81    2.87     .19|1.16    .9| .99    .0|  .69   .63| 58.0  61.6|  .91| C32   0 |
|   103     147     81    2.78     .19| .95   -.2| .89   -.5|  .64   .65| 64.2  63.5| 1.06| C33   0 |
|    34     121     68    2.46     .21| .65  -2.1| .64  -2.1|  .82   .75| 72.1  61.8| 1.35| A34   0 |
|    99     161     81    2.41     .18|1.11    .7|1.09    .6|  .57   .65| 51.9  58.8|  .92| C29   0 |
|    62     124     70    2.37     .19|1.19   1.1|1.16    .8|  .69   .73| 51.4  59.3|  .75| B27   0 |
|    98     152     81    2.12     .18|1.10    .6| .93   -.2|  .69   .69| 61.7  67.0|  .97| C28   0 |
|    94     165     81    2.09     .18|1.52   2.5|1.44   2.3|  .58   .69| 42.0  59.6|  .44| C24   0 |
|    35     136     68    2.00     .19|1.13    .8|1.08    .6|  .72   .71| 58.8  56.2|  .79| A35   0 |
|    27     116     69    1.99     .20| .76  -1.0| .59  -1.4|  .82   .77| 75.4  71.4| 1.19| A27   0 |
|    30     111     69    1.96     .22|1.17    .8|1.20    .7|  .71   .74| 65.2  72.2|  .89| A30   0 |
|    64     145     70    1.94     .18|1.38   2.2|1.43   2.4|  .62   .64| 44.3  51.2|  .54| B29   0 |
|    32     138     69    1.92     .19|1.32   1.7|1.25   1.4|  .69   .70| 50.7  57.3|  .57| A32   0 |
|    29     116     69    1.89     .20| .56  -2.0| .32  -1.5|  .81   .76| 76.8  74.6| 1.22| A29   0 |
|    28     138     69    1.84     .19| .71  -1.7| .71  -1.8|  .79   .75| 62.3  57.3| 1.31| A28   0 |
|    66     114     70    1.79     .21| .77   -.9| .80   -.7|  .87   .83| 72.9  69.5| 1.14| B31   0 |
|    95     173     81    1.73     .17|1.25   1.4|1.19   1.1|  .59   .67| 50.6  57.6|  .80| C25   0 |
|    59     134     70    1.71     .19|1.29   1.5|1.22   1.2|  .72   .77| 50.0  57.4|  .69| B24   0 |
|    31     133     69    1.71     .20| .73  -1.3| .71  -1.8|  .78   .78| 60.9  59.8| 1.29| A31   0 |
|   101     182     81    1.67     .16| .92   -.5|1.07    .5|  .67   .67| 59.3  54.1| 1.10| C31   0 |
|    69     152     70    1.61     .18| .81  -1.2| .81  -1.2|  .75   .70| 60.0  53.6| 1.24| B34   0 |
|    63     139     70    1.58     .16|1.26   1.4|1.37   1.5|  .67   .68| 52.9  54.4|  .74| B28   0 |
|    67     113     70    1.56     .20| .55  -1.6| .49  -1.5|  .83   .78| 82.9  75.9| 1.25| B32   0 |
|    65     123     70    1.56     .18|1.09    .4|1.47   1.5|  .74   .75| 55.7  64.0|  .76| B30   0 |
|    58     133     70    1.45     .20| .97   -.1|1.07    .4|  .82   .80| 51.4  62.5|  .86| B23   0 |
|    92     186     81    1.43     .17| .80  -1.1| .83  -1.1|  .67   .67| 54.3  56.9| 1.16| C22   0 |
|    68     149     70    1.40     .19| .73  -1.5| .78  -1.2|  .80   .76| 70.0  61.9| 1.16| B33   0 |
|   105     199     81    1.33     .17| .86   -.8| .90   -.6|  .67   .66| 55.6  58.0| 1.09| C35   0 |
|    70     168     70    1.30     .15| .76  -1.6| .73  -1.7|  .66   .61| 47.1  46.3| 1.28| B35   0 |
|   100     181     81    1.24     .17| .80  -1.1| .79   -.6|  .70   .68| 67.9  58.1| 1.18| C30   0 |
|    33     161     69    1.19     .19|1.34   1.6|1.31   1.6|  .74   .75| 53.6  60.1|  .62| A33   0 |
|    60     166     70    1.12     .16| .99    .0| .96   -.2|  .67   .68| 47.1  50.0| 1.06| B25   0 |
|    97     202     81    1.09     .17|1.30   1.6|1.03    .2|  .70   .68| 64.2  59.1|  .83| C27   0 |
|    23     143     69    1.03     .17| .66  -1.8| .60  -1.9|  .75   .71| 68.1  58.6| 1.27| A23   0 |
|    26     161     69     .97     .20|1.21    .9|1.15    .7|  .78   .78| 66.7  66.3|  .69| A26   0 |
|    89     184     81     .94     .15|1.02    .2|1.73   2.4|  .58   .66| 54.3  58.2|  .95| C19   0 |
|    55     134     70     .94     .17| .87   -.5| .92   -.1|  .73   .73| 52.9  60.4| 1.00| B20   0 |
|    51     142     70     .93     .16| .86   -.7| .81   -.7|  .74   .72| 61.4  56.2| 1.12| B16   0 |
|    25     150     69     .90     .17| .91   -.3| .85   -.3|  .74   .74| 53.6  56.3| 1.07| A25   0 |
|    20     156     69     .80     .16| .87   -.6| .92   -.4|  .71   .69| 55.1  53.0| 1.04| A20   0 |
|    96     197     81     .78     .17| .98    .0| .89   -.3|  .68   .67| 65.4  61.5|  .99| C26   0 |
|    93     234     81     .67     .16| .97   -.1| .98   -.1|  .64   .63| 51.9  50.4| 1.03| C23   0 |
|    48     151     70     .55     .15|1.19    .9|1.12    .6|  .68   .67| 50.0  55.7|  .96| B13   0 |
|    90     211     81     .55     .14|1.07    .5| .99    .1|  .63   .63| 43.2  50.4|  .91| C20   0 |
|    85     217     81     .38     .14| .85   -.8| .81  -1.1|  .64   .61| 48.1  49.7| 1.14| C15   0 |
|    87     219     81     .29     .15| .92   -.3| .88   -.4|  .65   .64| 56.8  56.3| 1.03| C17   0 |
|    57     183     70     .15     .15| .91   -.4| .93    .0|  .66   .66| 47.1  48.4| 1.00| B22   0 |
|    86     219     81     .12     .14| .68  -1.9| .60   -.4|  .63   .62| 60.5  52.6| 1.35| C16   0 |
|    81     241     81     .11     .14| .96   -.2| .95   -.2|  .61   .60| 42.0  46.6| 1.05| C11   0 |
|    56     177     70     .08     .15| .87   -.6| .82   -.4|  .65   .64| 55.7  50.6| 1.08| B21   0 |
|    84     256     81     .06     .15|1.20   1.3|1.21   1.2|  .50   .60| 50.6  49.1|  .79| C14   0 |
|    88     226     81     .04     .19| .67  -1.4| .81   -.4|  .68   .66| 76.5  70.6| 1.14| C18   0 |
|    16     185     69     .03     .15|1.02    .2|1.02    .2|  .62   .62| 52.2  50.0|  .94| A16   0 |
|    24     184     69     .03     .15| .69  -1.6| .69  -1.3|  .64   .62| 56.5  54.5| 1.22| A24   0 |
|    13     182     69     .02     .15| .81  -1.0| .73   -.9|  .62   .61| 58.0  50.0| 1.19| A13   0 |
|    17     186     69     .01     .14| .96   -.2| .87   -.3|  .61   .60| 40.6  43.1| 1.02| A17   0 |
|    22     189     69     .00     .15| .56  -2.8| .55  -1.8|  .67   .64| 59.4  52.6| 1.38| A22   0 |
|    15     197     69    -.02     .18|1.18    .9|1.11    .5|  .63   .69| 46.4  56.2|  .73| A15   0 |
|    46     190     70    -.16     .13| .70  -1.8| .68  -1.4|  .60   .58| 42.9  44.5| 1.27| B11   0 |
|    42     196      70     -.21      .13| .78   -1.3| .65   -1.5|  .60     .58| 58.6   44.1| 1.26| B7     0 |
|    54     196      70     -.23      .14| .67   -1.9|1.13     .6|  .58     .60| 55.7   48.6| 1.17| B19    0 |
|    11     207      69     -.27      .15|1.12     .7|1.05     .3|  .62     .61| 39.1   48.5|  .90| A11    0 |
|    82     272      81     -.33      .17|1.35    2.0|1.31    1.8|  .58     .60| 51.9   55.1|  .67| C12    0 |
|    21     208      69     -.36      .13| .85    -.8| .74   -1.0|  .55     .54| 55.1   42.1| 1.16| A21    0 |
|    47     202      70     -.45      .12| .93    -.3| .87    -.1|  .55     .55| 44.3   44.6| 1.03| B12    0 |
|    76     281      81     -.51      .12| .85   -1.0| .77   -1.1|  .54     .52| 55.6   44.7| 1.16| C6     0 |
|    83     267      81     -.54      .11|1.00     .1| .81    -.7|  .52     .51| 44.4   43.8| 1.06| C13    0 |
|    19     209      69     -.54      .15| .67   -1.7| .65   -1.1|  .58     .57| 59.4   51.8| 1.20| A19    0 |
|    80     279      81     -.60      .13| .96    -.2| .84    -.7|  .57     .55| 51.9   48.2| 1.07| C10    0 |
|    43     230      70     -.72      .13|1.01     .1| .95    -.1|  .53     .53| 47.1   41.0|  .98| B8     0 |
|    91     274      81     -.75      .15| .87    -.7| .75    -.8|  .61     .59| 58.0   53.2| 1.11| C21    0 |
|    10     227      69     -.76      .15| .67   -1.9| .63   -1.3|  .57     .56| 55.1   49.6| 1.24| A10    0 |
|    78     293      81     -.80      .13|1.02     .2| .95    -.1|  .53     .52| 48.1   46.5|  .98| C8     0 |
|    41     233      70     -.98      .12| .88    -.6| .68    -.6|  .49     .49| 52.9   47.0| 1.06| B6     0 |
|    53     253      70    -1.00      .14| .77   -1.4|1.33    1.5|  .46     .52| 44.3   44.7| 1.14| B18    0 |
|     9     248      69    -1.10      .12| .67   -2.1| .58   -1.5|  .50     .48| 47.8   43.3| 1.36| A9     0 |
|    18     249      69    -1.17      .14|1.12     .8|1.19     .9|  .52     .53| 42.0   45.7|  .87| A18    0 |
|    73     344      81    -1.19      .14|1.14     .9|1.10     .4|  .49     .49| 42.0   51.7|  .85| C3     0 |
|     8     320      69    -1.24      .16| .82   -1.1| .89    -.2|  .43     .42| 60.9   52.7| 1.20| A8     0 |
|    12     266      69    -1.37      .14|1.35    1.9|2.45    4.3|  .48     .50| 50.7   46.0|  .59| A12    0 |
|     7     275      69    -1.47      .13| .70   -1.9| .71   -1.1|  .48     .46| 47.8   45.2| 1.28| A7     0 |
|    52     279      70    -1.48      .12|1.12     .7|1.16     .5|  .44     .44| 42.9   41.8|  .87| B17    0 |
|    61     286      70    -1.57      .13|1.02     .2|1.09     .5|  .45     .45| 40.0   43.8|  .96| B26    0 |
|    49     279      70    -1.59      .14| .89    -.6| .84    -.7|  .50     .49| 55.7   45.4| 1.12| B14    0 |
|    14     282      69    -1.62      .14|1.27    1.4|1.38    1.2|  .44     .46| 39.1   47.2|  .75| A14    0 |
|    50     286      70    -1.73      .14| .89    -.6| .81    -.6|  .49     .48| 55.7   49.2| 1.10| B15    0 |
|    45     299      70    -1.75      .12| .78   -1.3| .66   -1.0|  .41     .39| 48.6   44.4| 1.23| B10    0 |
|    77     373      81    -1.84      .12| .74   -1.6| .75    -.4|  .39     .38| 54.3   47.2| 1.24| C7     0 |
|    44     361      70    -1.85      .15| .87    -.7| .84    -.2|  .32     .31| 55.7   53.3| 1.11| B9     0 |
|    74     377      81    -1.98      .13|1.05     .4|1.29     .7|  .39     .40| 48.1   49.4|  .91| C4     0 |
|    40     331      70    -2.18      .12|1.20    1.1|1.45     .9|  .32     .33| 50.0   49.2|  .87| B5     0 |
|    79     385      81    -2.19      .13| .85    -.8|1.00     .2|  .38     .38| 43.2   50.0| 1.01| C9     0 |
|    71     393      81    -2.27      .12|1.18    1.1|1.11     .4|  .34     .35| 40.7   50.0|  .78| C1     0 |
|    39     357      70    -2.28      .14| .82    -.9| .59    -.8|  .32     .30| 55.7   52.4| 1.15| B4     0 |
|    38     343      70    -2.28      .13| .85    -.7| .74    -.4|  .32     .31| 51.4   50.1| 1.13| B3     0 |
|     6     322      69    -2.35      .15| .76   -1.3| .66   -1.0|  .42     .40| 59.4   52.4| 1.25| A6     0 |
|    37     381      70    -2.38      .17| .73   -1.3| .82    -.2|  .27     .26| 67.1   63.1| 1.13| B2     0 |
|    72     412      81    -2.48      .12|1.04     .3|1.44     .9|  .29     .30| 53.1   55.1|  .86| C2     0 |
|     4     345      69    -2.56      .13|1.54    2.5|2.54    1.5|  .28     .31| 56.5   54.4|  .65| A4     0 |
|    75     439      81    -2.62      .16|1.12     .8|9.90    7.7|  .24     .28| 56.8   60.1|  .54| C5     0 |
|     3     346      69    -2.67      .15| .79   -1.0| .81    -.3|  .36     .34| 55.1   52.3| 1.18| A3     0 |
|    36     371      70    -2.72      .14|2.45    4.7|3.82    2.2|  .18     .25| 55.7   63.5| -.19| B1     0 |
|     1     378      69    -3.05      .15|1.05     .3|1.10     .4|  .21     .22| 75.4   71.6|  .98| A1     0 |
|     2     397      69    -3.15      .16|1.29     .9|9.90    4.0|  .10     .13| 82.6   85.4|  .61| A2     0 |
|     5     389      69    -3.17      .17| .71    -.9| .55    -.1|  .20     .19| 82.6   80.2| 1.08| A5     0 |
|-----------------------------------+----------+----------+-----------+-----------+-----+---------|
| MEAN   225.9    73.3      .00      .16| .97    -.2|1.16     .0|             | 55.4   54.7|     |         |
| S.D.    84.8     5.5     1.60      .03| .26    1.3|1.29    1.4|             |  9.8    8.7|     |         |
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Appendix B: MTC Spanish Elicited Imitation Test Ordered by Difficulty Level

1. El bautismo es esencial.
2. Mi hermano es menor que yo.
3. El Libro de Mormón nos enseña la verdad.
4. Yo tengo dos hermanas, pero tú tienes tres.
5. Hace un mes que los visitamos.
6. Jesús creó la tierra.
7. Debemos seguir al profeta.
8. Dios mora en los cielos.
9. El albedrío es un principio eterno.
10. Nos gustaría pasar y ver cómo le va.
11. Todo lo bueno proviene de Dios.
12. ?Cual es la diferencia entre un profeta y un apostol?
13. Les pedimos que leyeran dos capítulos.
14. El Espíritu Santo nos testificará que Jesucristo es nuestro Salvador y Redentor.
15. Jesús pasó Su vida al servicio de los demás.
16. Las personas que se arrepienten son perdonadas.
17. Este mensaje de la Restauración es verdadero o no lo es.
18. Adán y Eva fueron separados de la presencia de Dios.
19. Yo me levanto a las cuatro de la madrugada.
20. El plan de salvación nos proporciona la respuesta a preguntas.
21. Estaremos enseñando a alguien a esa hora mañana.
22. Jesús obedeció todo lo que Su Padre Celestial le pidió.
23. Nadie puede saber las verdades espirituales sin la oración.
24. De la transgresión resultaron grandes bendiciones.
25. Las Escrituras están disponibles para nosotros en la actualidad.
26. Las enseñanzas de los profetas se encuentran en libros sagrados llamados Escrituras.
27. Debido a la resurrección de Jesucristo, todos seremos resucitados.
28. Dios tiene un cuerpo de carne y huesos perfecto, glorificado e inmortal.
29. Nosotros permaneceremos en el mundo de los espíritus hasta que seamos resucitados.
30. ¿Invitará a amigos y familiares a fijar una cita con los misioneros?
31. Si planificáramos con más eficacia, nuestras lecciones serían mejores.
32. Enós llevaba mucho tiempo orando cuando recibió una respuesta.
33. Quiero llegar a ser como el capitán Moroni, lleno de amor y fuerza para luchar contra el mal.
34. De esta manera, los investigadores podrán recibir un testimonio de la veracidad de las Escrituras.
35. Los poseedores del sacerdocio deben presidir con amor y bondad.
36. A través de todas las épocas, Dios ha llamado profetas para que guíen a la humanidad.
37. Al restaurar el Evangelio, Dios le dio nuevamente al hombre el sacerdocio.
38. Se nos ha mandado hacer oraciones familiares para que nuestra familia sea bendecida.
39. Nuestro Padre Celestial delega Su poder del sacerdocio a los varones dignos que son miembros de la Iglesia.
40. Decidí leer y después pedir a Dios que me hiciera saber que el libro era verdadero.

41. Por conducto de Su Hijo Jesucristo, Dios creó los cielos y la tierra y todas las cosas que hay en ellos.
42. Durante Su ministerio terrenal, el Salvador enseñó Su Evangelio y realizó muchos milagros.
43. Podemos fijar una fecha para la que habremos encontrado a alguien con quien compartir el Evangelio.