EFFECT OF TESTING LANGUAGE ON ImPACT SCORES IN NON-NATIVE ENGLISH SPEAKERS

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Title of Study: EFFECT OF TESTING LANGUAGE ON ImPACT SCORES IN NON-NATIVE ENGLISH SPEAKERS

Major Field: HEALTH AND HUMAN PERFORMANCE – ATHLETIC TRAINING

Scope and Method of Study: As the number of foreign-born student-athletes in NCAA sports continues to grow, finding accurate ways to evaluate concussions in spite of language and cultural differences is imperative to providing quality athletic healthcare. The purpose of this study was to determine if a difference in scores on the web-based ImPACT concussion assessment exists when non-native English speakers take the test in their native language versus in English. The study also sought to determine if the magnitude of the difference is associated with previous exposure to the English language. Thirty healthy subjects (22 female, 8 male, age 24.4 ±3.9) completed the ImPACT test twice in a controlled environment, first in their native language and then approximately two weeks later in English. Information regarding the number of years that subjects had lived in a primarily English-speaking country and the number of years of formal English education they had received was also collected to assess previous exposure to the language.

Findings and Conclusions: A paired samples t-test was conducted on each of the composite scores generated by ImPACT along with the total symptom score and the Cognitive Efficiency Index. The results showed that subjects tested better in their native language on scores for verbal memory, visual motor speed, and Cognitive Efficiency Index ($p<.05$). Analysis did not find a correlation between the magnitude of the difference for any test scores and either measure of previous English exposure. Anecdotal evidence from the study also reveals that clinicians should be aware of the effect of language on symptom scoring, though a difference based on testing language did not reach statistical significance. Overall, the data suggest that, regardless of a student-athlete's previous experience with the English language, he/she should take the ImPACT test in his/her native language whenever possible to provide the most accurate measure of neurocognitive functioning. Future research should investigate if testing language affects scores on other concussion assessments as well as determining if score differences become more pronounced on a post-concussion test.

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CHAPTER I

INTRODUCTION

Concussions continue to be a major point of focus in the sports medicine community. An estimated 1.6-3.8 million sports-related mild traumatic brain injuries (mTBI) occur each year in the United States, with the majority of these being concussions.[1,2] Concussions can present with a variety of physical, emotional, and cognitive symptoms including headache, dizziness, irritability, sensitivity to light and sound, emotional distress, and neuropsychological impairment, making initial clinical presentation vary considerably from case to case.[1,3] Beyond these initial symptoms, mTBI can cause long-term cognitive deficits and can lead to Post-Concussive Syndrome, in which symptoms last longer than three months.[3,4] With such a high incidence and potentially serious short- and long-term effects, appropriately evaluating and managing concussions is essential.

Despite the importance of proper evaluation and management of this condition, there is not a consensus among sports medicine professionals as to how this is best accomplished. There have been a multitude of studies conducted on this topic, yet they've failed to reach a conclusion based on scientific research.[1] There are many types of evaluation and management tools, both paper and computerized versions, in existence including sideline assessment tools, balance tests, symptoms checklists and neurocognitive assessments. Use of computerized neurocognitive assessments has been on the rise as experts and position statements from various groups have

endorsed their usage.[5,6] One of the most widely used computerized tests for the evaluation and management of concussions is the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) system.[1,5-7]

ImPACT was designed specifically to identify the effects of sport-related concussions on cognitive function.[8] In addition to initial evaluation, it is also used for tracking recovery.[9] The ImPACT test is a computerized neurocognitive test with both software and online versions that tracks symptoms and measures cognitive impairment. The test takes approximately twenty minutes to complete and consists of three sections. The first section collects demographic information and includes a health history questionnaire. The second section is a symptoms checklist, asking users to rate their current severity of twenty-two common concussion symptoms on a seven-point Likert scale. The third section is comprised of neuropsychological tests, taking users through six modules. These modules measure numerous aspects of cognitive functioning including: attention span; working memory; sustained and selective attention time; response variability; non-verbal problem solving; and reaction time. Scores are then automatically calculated by the program and listed in a report.[7]

To ensure the most effective use of neurocognitive tests, gathering pre-season baseline measures is essential.[4,7] Having a stable and reliable baseline is important for accurate, individualized comparisons with post-concussion test results.[5,6] It allows each individual to serve as his/her own control and allows clinicians to determine what is normal for that individual since many variables can affect the test.[5,9]

Although research has proposed that cultural and linguistic differences may affect neurocognitive test scores,[2-4,10,11] differences when testing in other languages have not been researched.[10] While the ImPACT test is currently offered in sixteen languages other than English, the company ImPACT Applications, Inc. stated in an email (Personal Communication, April 11, 2013) that they have no research data regarding the differences, validity or reliability of the test when offered in another language. Furthermore, any relevant research involving ImPACT has

failed to test a multicultural sample or has specifically excluded those who are non-native English speakers.[2,3,5,11] This study will investigate the effects of language on ImPACT scores.

Over the past decade, the number of foreign athletes participating in National Collegiate Athletic Association (NCAA) sports has increased drastically, with the percentage of female athletes from foreign countries nearly tripling.[12] With increasing numbers of foreign athletes in college athletics, many of whom do not speak English as their native language, it's important to consider how this may affect ImPACT scores. Healthcare providers must be able to accurately evaluate and manage concussions in non-native English speakers in order to continue meeting a high standard of care for a diverse population. This study aims to fill a gap in the existing literature by investigating the relationship between language and ImPACT results. To our knowledge, this is the first research to investigate linguistic differences regarding the ImPACT test.

Research Question

This study has both a primary and a secondary research question:

- Primary: In healthy individuals that are non-native English speakers, does taking the ImPACT test in their native language rather than in English have an effect on their scores?
- Secondary: If a difference in scores is found to exist between testing languages, does the amount of exposure to the English language affect the amount of score change?

Hypothesis

- Primary Research Question
    - H_1: A difference in non-native English speakers' ImPACT scores will be found when tested in their native language versus in English.

- Secondary Research Question
    - H_2: Subjects with greater exposure to the English language will have less score change than subjects with less exposure.

Definition of Terms

The following terms are relevant to this study:

- Healthy: Persons not currently suffering from any acute illness and with no recent history of head injury.
- Non-native English speaker: Person for whom English is not his/her first language.
- Native language: The primary, or first, language spoken by a person.
- Exposure to English: The number of years spent living in English-speaking countries and/or taking formal English language courses in school.
- Scores: The scores constructed from performance on the ImPACT test modules and reported as results; the following composite scores will be used for analysis: Verbal Memory composite; Visual Memory composite; Visual-Motor Speed composite; Reaction Time composite; and Impulse Control composite. In addition the Cognitive Efficiency Index and Symptom Score Composite will be included in analysis.

Assumptions

The following assumptions apply to this study:

- Subjects will put forth their best effort in taking the test both times.
- Subjects will truthfully evaluate their level of symptoms using the symptoms score checklist included in the ImPACT test.
- Scores on the second round of testing will not be significantly affected by practice effects from completing the test two weeks prior; any observed differences in scores will represent true score change rather than learned practice effects.

- Subjects will truthfully answer the pre-test questionnaire regarding the number of years they have lived in English-speaking countries, the number of years of formal English-language courses taken in school, and their concussion history.
- Subjects will have sufficient proficiency in English to take the ImPACT test in English with at least a basic understanding of test instructions.
- Subjects will have sufficient proficiency in English to comprehend and answer the questions asked on the pre-test questionnaire.

Delimitations

The following delimitations are necessary to carry out this study:

- The subject sample of non-native English speakers will be chosen from the international student population at Oklahoma State University.
- In order to have a sufficient subject sample size, non-athletes will be included as subjects.
- Only subjects whose native language is one of the sixteen foreign languages in which the ImPACT test is offered will be eligible for the study.

Limitations

The following limitation is known to apply to this study:

- ImPACT test was designed for use on athletes so testing non-athletes in this study may affect the generalizability of the results to an athletic population.

CHAPTER II

REVIEW OF LITERATURE

This study was designed to investigate the effects that language has on ImPACT test scores in non-native English speakers. Due to the lack of relevant research, this literature review will instead focus on providing background information and developing a theoretical justification as to why an effect of language on scores may be found. It will also discuss the use of the ImPACT test for this study and the importance of cultural competency to healthcare providers, specifically sensitivity to language differences.

Concussion Testing

Accurate evaluation of a concussion after it occurs is a priority for sports medicine providers. Each concussion presents in a unique manner and assessment can be complicated by the variety of subjective symptoms and objective clinical signs that accompany a concussion.[1,13,14] To assist in evaluating athletes suspected of having a concussion, numerous assessment tools have been developed. Each type of test has its own advantages and limitations but no one test has been shown to reliably identify concussions in all cases.[1]

Sideline assessments were developed to be administered soon after the occurrence of a concussion. Although this can make research in a controlled setting difficult, many studies have been conducted to determine the validity and reliability of these tools. The most common sideline

assessments involving language are the Standardized Assessment of Concussion (SAC) test and the Sports Concussion Assessment Tool – version 2 (SCAT2).[1] While these tools test multiple aspects of cognitive function that are affected by concussion, they each have disadvantages that prevented them from being chosen for use in this study.

The SAC test is a brief mental status and neurologic screening tool designed to assess the immediate effects of a concussion by testing orientation, immediate memory, concentration, and delayed recall.[15] While it has been shown to be resistant to practice effects,[1,15] it has a low correlation with some other neuropsychological tests, suggesting that it may not be comprehensive or sufficiently valid.[1,16] The test is primarily useful when administered within hours of concussion and compared to baseline results,[1] though some studies have questioned its specificity for immediate post-concussion testing.[4] It is generally agreed that SAC is not appropriate for use as a stand-alone test nor is it adequate to track recovery and determine return to play.[1,9,15] The reliability of this test has also been called into question as a previous study determined test-retest reliability was relatively low with a correlation coefficient of r=.55.[15] Due to this low reliability in repeat testing, it is possible to see statistically significant variation in a subject's scores despite having no change in neurobehavioral status.[15] Research by Dikmen, et al. found two components of the SAC, digit span and recall, have poorer reliability than other measures of neurocognitive function.[17] Because the SAC test is administered and scored by a sports medicine professional, typically an athletic trainer, the results are subject to bias. The SCAT-2 evaluation tool, of which the SAC test is a component, also requires a sports medicine professional for administration, allowing for possible biasing of results. It includes multiple tests, some of which have limited reliability or demonstrate practice effects.[1]

Comprehensive computerized neurocognitive tests are recognized as the most accurate means to evaluate concussions.[1] These tests are easy to administer, decrease practice effects, and have increased test-retest reliability.[5,6] Like the previously discussed tests, the ImPACT test also assesses many areas of neurocognitive function. However, in contrast with the SAC and SCAT-2,

its administration via computer rather than by another person and automatic score generation reduce chances of investigator bias when used in research.[6] Because the test is computerized, it is able to minimize practice effects through the use of multiple forms and random organization,[5,7,8] unlike the SCAT-2. It is important to control for practice effects in a concussion management tool such as ImPACT, as it will be administered numerous times over a short time interval.[5] In a study on version 1.0 of ImPACT, there was no practice effect observed over a two-week period.[18] Another study found a minimal practice effect on the processing speed (visual-motor speed) composite but no effect on the other reported scores.[8] While some research has suggested lower validity of the SAC test, ImPACT is regarded as having high validity, having been correlated with other neurocognitive tests and functional magnetic resonance imaging (fMRI), which is the gold standard in determining brain function.[1] Numerous studies have also confirmed the test-retest reliability of ImPACT.[5,6,8] A study by Iverson et al. on ImPACT version 2.0 found test-retest correlation coefficients over a seven day span ranging from r=.65 on the total symptom score composite to r=.86 on the processing speed (visual-motor speed) composite. These values are comparable or higher than what is seen in many other neurocognitive tests.[8] It is also necessary to establish long-term reliability as months or years may elapse between baseline testing and post-concussive testing.[6] A study that involved four-month repeat testing on non-concussed football players found no decline in scores.[19] A research study on one-year test-retest reliability found that scores showed substantial stability over this period.[5] Another study by Schatz looked at two-year reliability so as to make baseline frequency recommendations in the college athletics setting. The data showed no significant differences between the two baseline scores using paired t-tests and regression based measures confirmed that the scores had considerable stability.[6]

The current study is choosing to examine the effects of language on the ImPACT test for several reasons. It shows minimal practice effects in contrast to SCAT-2 and potentially greater validity than SAC. In addition, ImPACT demonstrates increased reliability as compared to SAC

and SCAT-2 assessments along with a reduced chance for investigator bias as a confounding variable or limitation.

Relationship of cognitive ability to ImPACT and academic achievement

The ImPACT test was designed as an evaluation of cognitive functions that may be affected by mTBI. As with other neurocognitive tests, it is intended to measure aspects of cognition including concentration, visual memory, verbal memory, information processing, and executive function.[4] Studies have shown a strong relationship (r=.75-.95) between cognitive ability and certain aspects tested by neurocognitive assessments, including verbal ability, spatial ability, and non-verbal reasoning ability, lending support for the validity of these tests.[20,21] Two constructs directly tested by ImPACT, processing speed and working memory, are also strong components of cognitive ability.[21] These relationships suggest a clear association between performance on these assessments and cognitive ability. In addition, superior performance on neurocognitive assessments has been correlated with increased education.[22]

Academic achievement in education, like neurocognitive testing, is considered a measure of cognition. Although many factors can influence academic success, one study showed cognitive capability and academic achievement to have a correlation of r=.68.[20] Another study also confirmed the strong association between general cognitive ability and academic achievement, finding statistically significant correlations between cognition and verbal, mathematical and overall academic success as measured by grade point average (GPA).[21] This study reported that cognitive capability can account for up to 54% of the variance in academic achievement. Cognitive ability is one of the most commonly used and most accurate predictors of academic achievement due to this strong relationship.[20,21] A study investigating the association between cognitive abilities and academic achievement in a multicultural sample found that this relationship remained strong across different ethnic/cultural groups.[20]

Relationship of cognitive ability and academic achievement to language

While a link between cognitive ability and academic achievement has been confirmed by numerous studies, a relationship between language ability and academic success has also been consistently demonstrated.[20,23] According to a review by Andrade, in non-native English speakers attending English-speaking universities, higher scores on the Test of English as a Foreign Language (TOEFL), which indicates greater English proficiency, are correlated with higher GPAs.[23] The author also stated that qualitative data has revealed professors feel the main obstacle facing international students academically is language proficiency. These same students agreed that English language skills affected their academic success. An additional study found that first-year international students described difficulties understanding lectures due to vocabulary usage and the speed at which instructors speak.[23] Developing vocabulary is essential for academic success in a second language.[24]

International students reported having to read academic materials multiple times for sufficient comprehension and were found to read at a slower pace than native English speakers. Subsequently, better English reading abilities in international students have been linked to higher academic achievement. A study of international students in an Australian university discovered that 76% of non-native English speaking students were judged as needing intensive language support due to poor proficiency despite having adequate TOEFL scores for university admission.[23]

When investigating the relationship between English skills in non-native speakers and academic achievement, one of the main factors that must be examined is exposure to the English language. One study found that immigrants going to school exclusively in the second language take five to seven years to reach native-speaker norms for academic performance.[25] This time frame to reach equivalent academic achievement may actually be closer to seven to ten years, even in those students with a strong academic background.[24] Two studies by Collier discovered that students arriving in the United States between twelve and sixteen years of age were still at or

below the 35th percentile after six years of formal education in English in all subjects except for math, which does not require the same levels of language proficiency.[26,27] Students beyond puberty, such as college and university students, with solid cognitive development in their native language have shown proficiency in basic second language skills within two to three years. However, academic performance in these students once beginning courses taught solely in the second language still fell below that of native speakers,[24] as they were listening to lectures they were unable to fully understand.[23,24] Native-language instruction throughout elementary school while gradually introducing a second language is the optimal learning set-up for maximizing academic achievement in the second language. Many studies show that bilingual education is the most effective way to learn a second language, rather than full immersion into second language-only classes.[24]

Residence in a country speaking the student's second language results in exposure to the language outside of the classroom. This has been found to be a significant variable on language proficiency tests. However, formal educational instruction in the second language beyond natural exposure from residence must not be overlooked, as it improves student performance on second language tests.[24] A review article suggested that formal language study in classrooms in their home country may better prepare non-native English speaking international students for academic success due to the focus on language, grammar, and reading skills.[23] This research suggests that there are great gains in English proficiency during the first several years of English education or residence in an English-speaking country.

Relationship of neurocognitive tests to language and culture

The complex relationship demonstrated between culture, cognitive ability, and language as influences on academic achievement is also found with neurocognitive testing. Multiple studies have noted a lack of research on this area.[2] Some researchers argue that culture and cognitive ability are automatically linked, making the development of a "culture-free" test impossible.[10,22] Some cultural factors found to affect performance on neurocognitive assessments

include time perception, attitude toward testing, language, values and meanings, methods of learning and communicating, approaches to problem solving, and patterns of abilities.[10,11] Researchers have speculated that tests may be developed with cultural bias as they were designed for well-educated white individuals,[2] with ImPACT being developed and normed in the United States.[11] With its increasing use in other countries and in foreign languages, it is essential to consider the effects that culture and language may have on results.[11] When ImPACT is tested on a multi-ethnic sample, much of the variability found in different ethnic groups' performance may be attributed to educational levels, and reading level in particular. Thus, testing non-native English speakers in their native language, as the current study is investigating, may correct for a lack of subjects' mastery of the English language.[2] One study examining differences in performance between African American and white subjects and another study testing white South Africans and white Americans found no significant differences in scores, leading the researchers to conclude that ImPACT was a culturally equivalent test. However, no other cultural/ethnic groups were tested in these studies, limiting the generalizability of this conclusion.[2,11]

It is often assumed that neurocognitive tests are free from the influence of culture if verbal items are not used and only non-verbal tasks are tested. Some researchers have actually found larger differences in performance on non-verbal tasks as compared to verbal tasks across different cultural groups though, as culture has a significant effect on non-verbal skill development.[22] While neurocognitive assessments often use non-verbal and visual-spatial abilities tests in an attempt to decrease the effect of culture on performance, many of the tasks used are still culturally dependent. Some cultures are found to perform poorly on tests of non-verbal ability simply due to lack of familiarity with the skill being tested, such as copying a drawing.[22] In addition, the importance of speed, which is often measured in neurocognitive assessments, is a culturally based value that is common in the United States but not in other cultures.[10,11,22] A study investigating the differences in performance on numerous neurocognitive tests between Russians and Americans found a significant interaction on timed tests between test performance and

culture. If American norms were used to classify the performance of the Russian subjects, 27.5% would have scored in the borderline to impaired range, despite having no cognitive impairments.[10] The study concluded that existing neurocognitive evaluation tools are not universal and may be culturally biased in favor of Western cultures. The researchers argued that these tests must be assessed for cultural equivalence and advocated for the development of norms for non-Western cultures until universal assessments can be developed.[10] Another study on a multicultural sample maintained that because cross-cultural research is scarce, this makes individualized baselines even more essential so that people can serve as their own control, rather than being compared to normative values.[11]

Relationship of language and culture to concussive symptom reporting

In addition to affecting performance on neurocognitive tests, culture and language have also been shown to influence experience and reporting of concussion symptoms on symptoms checklists like the one included in ImPACT.[3,11] Culture has a demonstrated effect on pain perception, behavior, and manifestation of stress.[3] A study on ImPACT testing on South African versus American athletes, all of whom were native English speakers, found that the South Africans always had higher symptoms scores by three to five points, which had a clinically relevant effect size.[11] Culture-specific sensitivity to reporting symptoms differed between the two groups, creating non-equivalent norms. Investigators speculated that this may be caused by varying health-related attitudes or different interpretation of the symptom terminology between the two nations.[11] If a disparity was found between two groups from English-speaking nations, it is highly likely that a discrepancy in interpretation would be seen among groups with different native languages. Research on concussive symptoms across four cultural groups (Caucasian, Chinese/Filipino/Southeast Asian, African, and Arab/West Asian/South Asian) found differences in symptom incidence and severity.[3] Those of African descent more often suffered headache and reported more severe headache symptoms than the Caucasian or Southeast Asian groups. Whereas headache and poor concentration were the most common symptoms experienced by

African subjects, those from Southeast Asia reported dizziness while Caucasians reported sleep disturbances most often. Overall, non-Caucasians scored more symptoms than Caucasians, including the above symptoms as well as forgetfulness, sensitivity to light and noise, and depressed moods.[3] Researchers concluded that the presence or lingering of certain symptoms after a concussion may not be due to post-concussive syndrome or lack of recovery but instead may be caused by cultural and linguistic differences leading to a higher prevalence of those symptoms in healthy people of that culture. As with previous studies on multicultural samples, this emphasizes the importance of attaining individual baseline scores since comparing someone to normative values may be misleading due to cultural or linguistic differences.

Effects of language and culture on healthcare

The effects of culture and language on concussion tests and symptom reporting are also evident on healthcare in a broader sense. Language and culture affect health care beliefs, choices, and treatments.[28,29] Language differences between patient and healthcare provider can lead to poorer health-related outcomes unless steps are taken to address the potential effects. With language differences presenting an obstacle to optimal care for 21% of minorities in the United States receiving health care, this is a major issue facing healthcare providers.[28] Language barriers have been shown to have a negative impact on health care service utilization, adherence, and satisfaction. In particular, limited English proficiency is correlated with fewer physician visits and reduced usage of preventative health services.[28] Failing to address communication issues can directly affect patient care. Language differences can lead to miscommunication which can cause diagnostic and treatment errors.[28] Studies have shown that physicians order more diagnostic tests to overcome this communication difficulty, resulting in unnecessary tests and increased costs to the patient. One common way to improve communication with non-native English speakers is to provide foreign language interpreters. Some studies have shown that foreigners with poor language skills are more likely to seek health care if they know that interpreters are available to them.[28] Having interpreters available to those with limited proficiency in English can allow these

patients to better clarify their beliefs and feelings in addition to providing more relevant health information to the healthcare provider. While it is important to remember that aspects of culture are intertwined and not independent,[30] addressing the language barriers that are faced by non-native English speakers when seeking health care is an important aspect of providing culturally competent care.[28-30]

Importance of cultural competency in healthcare

With rising numbers of minorities in the United States, ensuring that healthcare takes into account linguistic and cultural differences is essential.[28,29,31] Census data reveals that approximately one-third of American residents belong to a minority group; within college athletics, the percentage is similar.[31] Minorities receive less health care and suffer worse health than those belonging to the majority group in any given place; increasing cultural competence can help to decrease this discrepancy.[28,29] Cultural competence in health care has been defined in many ways. One study describes it as understanding and integrating differences while incorporating them into daily care in order to most effectively provide cross-cultural care.[31] Another defines it as adapting healthcare to fit the individual patient, keeping in mind their unique culture and background and realizing the effects these may have on their healthcare.[30] A model of providing culturally competent care defined it as an ongoing process in which healthcare providers work to improve their ability to work with patients of different cultures by integrating cultural awareness, knowledge, skill, desire, and cross-cultural encounters.[29] Training healthcare providers in cultural competence can improve self-awareness of their attitudes toward minorities, increase their knowledge about minority populations, and improve specific skills like cross-cultural communication. This can help increase patient-provider trust, improve treatment outcomes and lead to higher satisfaction with healthcare services. In a society that values informed consent, choice of providers, and equality, cultural competence is a matter of social justice.[28]

Investigation of a potential relationship between language and ImPACT scores

This study seeks to investigate the effects that language has on ImPACT test scores in non-native English speakers. Because research has shown that language and culture affect academic achievement, it is plausible that they may also have an effect on ImPACT test results since both are measures of cognitive abilities. It is vital to consider this effect due to the importance of obtaining valid baseline assessments on international athletes before the occurrence of a concussion. Baseline concussion testing is typically performed prior to the start of an athlete's first season of participation. It is probable that this takes place shortly after arrival in the country for foreign athletes, which means they likely are not yet fully proficient in English regardless of their TOEFL scores or previous language experience. With the increasing command of English that these non-native speakers develop during their time as collegiate athletes, athletic trainers and team physicians need to ensure that baseline tests evaluate true cognitive ability without current level of English proficiency as an influence. Looking into the effect of language on concussion assessments is just one area that sports medicine providers need to consider when adjusting to the unique challenges of caring for an increasingly diverse population. Taking the cultural and linguistic background of non-native English speaking athletes into account can help healthcare professionals improve their cultural competency in order to provide the most effective care possible to this growing populace.

CHAPTER III

METHODOLOGY

Subjects

The subjects in this study were healthy, non-native English speakers who were current students at Oklahoma State University. In order to be eligible for the study participants could not have taken the ImPACT test previously. The native languages of the subjects were one of the sixteen foreign languages in which ImPACT Applications Inc. offers the ImPACT test (Portuguese, Swedish, Norwegian, German, French, Spanish, Italian, Czech, Russian, Mandarin, Finnish, Afrikaans, Hungarian, Korean, Japanese and Cantonese). Exclusion criteria for participation in the study included current illness and history of concussion within the previous five years. If a subject sustained a concussion or other head injury during the two-week period between testing sessions or became acutely ill, his/her scores were not used in data analysis. All subjects were required to sign a consent form indicating the voluntary nature of their participation in the study and their understanding of the study's methods. Thirty-one subjects were enrolled initially; one became ill during the course of the study and no longer met the inclusion criteria therefore scores from thirty subjects were included in data analysis. The study included eight males and twenty-two females with a mean age of 24.4 ± 3.9 years (range 18-34).

The native languages of the subjects used for testing are shown below in Table 1.

Table 1. Native Language of Subjects	
Language	**Number**
Spanish	10
Mandarin	7
Portuguese	2
Korean	2
Czech	2
Norwegian	2
French	2
Russian	1
Swedish	1
Japanese	1

Methods

Potential subjects who were international students at Oklahoma State University (OSU) were contacted with assistance from the Office of International Students and Scholars (ISS). The manager of the ISS Office sent an invitation email on behalf of the primary investigator (PI) to international students at OSU via their listserv. In the invitation email, interested students were directed to respond to the PI via email and asked to complete a pre-participation eligibility questionnaire regarding age, native language, history of concussion and their current health status (no acute illness). Potential subjects meeting eligibility requirements were assigned a time to complete the first session of testing. On their test date, subjects were asked to sign an informed consent form and fill out a pre-test questionnaire that was used to collect information about the number of years they have lived in an English-speaking country and/or taken formal English classes. The consent document and questionnaire can be found in the appendix. Subjects then completed the ImPACT test (version 2.1) in a quiet, controlled environment with outside distractions minimized. The first round of testing was conducted in English. The subjects returned approximately two weeks later to take the ImPACT test again, this time in their native language.

Before the second test, they verified that they were not acutely ill and had not sustained a head injury since taking the ImPACT test in English. Following the second round of testing, score reports automatically generated from the test were used in data analysis.

Data Analysis

Data analysis was completed using the five composite scores generated by the ImPACT test: Verbal Memory; Visual Memory; Visual-Motor Speed; Reaction Time; Impulse Control. In addition, analysis included the Cognitive Efficiency Index score and the Symptom Score Composite. For each of the seven scores, a paired samples t-test was used to determine if any significant differences exist between the test scores from the English test and the test scores from the subjects' native language test. Difference scores were then calculated for each of the subjects' seven scores by subtracting the English test score from the native language test score. A correlation analysis was performed to identify potential correlations between the number of years the subject has spent in an English-speaking country and/or the number of years of formal English classes and the magnitude of the difference score. Difference scores were included in the analysis so that each subject served as his/her own comparison to minimize confounding variables. A post-hoc one-way ANOVA was conducted to determine if there was an interaction between gender and magnitude of the difference score for each of the seven scores. A post-hoc statistical power analysis was also conducted using the software package GPower (Faul and Erdfelder 1992), with a sample size of 30.

CHAPTER IV

FINDINGS

Primary Research Question

The primary research purpose of this study was to determine if a difference exists between ImPACT scores when non-native English speakers take the test in English versus when taking the test in their native language. The ImPACT test score reports generated five composite scores representing different areas of cognitive functioning: Verbal Memory, Visual Memory, Visual Motor Speed, Reaction Time, and Impulse Control. These five composite scores along with the Cognitive Efficiency Index and the Symptom Score Composite were compared to look for differences between the English test scores and the native language test scores. The Cognitive Efficiency Index is a number calculated by ImPACT based on the interaction of speed and accuracy in the subjects' performance on the Symbol Matching task.[32] Of the seven score comparisons, statistically significant differences were found in three: Verbal Memory, Visual Motor Speed, and Cognitive Efficiency Index. Results for the paired samples comparisons are shown in Table 2.

The mean Verbal Memory score was 82.10 ± 8.71 in English and 89.03 ± 9.53 in subjects' native language. The t-value for this comparison was -4.058, with a significance of p=0.000. This showed a statistically significant difference in Verbal Memory score between the

two languages (p<.05). For this comparison, there was an effect size of r=0.61 and a power of 0.99. Another score that showed a difference was Visual Motor Speed, which had means of 39.51 ± 5.68 in English and 42.33 ± 6.99 in the native language. With a t-value of -3.982 and a significance of p=0.000, the difference between the scores reached statistical significance (p<.05). The Visual Motor Speed difference had an effect size of r=0.60 and a power of 0.99. In addition to the differences found for these two composite scores, we discovered that there is a significant difference for Cognitive Efficiency Index (p<.05). The mean score for Cognitive Efficiency Index in English was 0.26 ± 0.12 and in subjects' native language was 0.37 ± 0.14. This produced a t-value of -4.607 and a significance of p=0.000. The effect size for this score difference was r=0.61 with a power of 0.99.

Table 2. Paired Samples t-test, N = 30

Variable	**Language**	**Mean**	**St.D**	**95% CI of the Difference**	**t**	**p**
Verbal Memory	English	82.10	8.72	-10.43, -3.44	-4.058	.000
	Native	89.03	9.53			
Visual Memory	English	71.20	13.00	-6.70, 4.50	-0.402	.691
	Native	72.30	14.71			
Visual Motor Speed	English	39.51	5.68	-4.28, -1.37	-3.982	.000
	Native	42.33	6.97			
Reaction Time	English	0.59	0.08	-0.03, 0.01	-0.677	.504
	Native	0.60	0.08			
Impulse Control	English	5.10	4.35	-0.79, 1.26	0.467	.644
	Native	4.87	4.09			
Cognitive Efficiency Index	English	0.26	0.12	-0.16, -0.06	-4.607	.000
	Native	0.37	0.14			
Symptom Score Composite	English	16.30	20.96	-0.86, 8.12	1.655	.109
	Native	12.67	16.37			

The Symptom Score Composite, based on subjects' experience of 22 common concussion symptoms, had a mean of 16.30 ± 20.96 for the English test and 12.67 ± 16.37 for the native language test. The test for this comparison lacked significance (t=1.655, p=0.109). However, anecdotal evidence from this study suggests some effect of language on symptom score reporting.

Numerous subjects approached the researcher with questions regarding the meaning of certain words used to describe the symptoms during the English testing. The most common symptom descriptions that subjects either did not recognize or did not understand in English were "dizziness" and "drowsiness". These symptoms were scored as a zero on a seven-point Likert scale (0-6) of frequency and intensity of symptom experience by subjects not understanding the description.

Secondary Research Question

The secondary purpose of this research study was to determine if there is a relationship between any score differences that exist and the amount of exposure that a subject has had to the English language. After difference scores were calculated by subtracting the English test score from the native language test score, analyses then set to identify potential correlation to the number of years a subject had lived in a primarily English-speaking country and to the number of years of formal English education that a subject had. The mean number of years that subjects had lived in a primarily English-speaking country was 3.00 ± 3.49 years and they had a mean of 7.42 ± 4.04 years of formal English education. Means and standard deviations for each of the difference scores used in determining correlation are shown in Table 3.

The amount of difference in score from English test to native language test failed to reach statistically significant correlation ($p<.05$) to the number of years living in an English-speaking country for each of the seven measures with which analysis was concerned. We also failed to find a correlation between these seven difference scores and the number of years of formal English-language education that subjects had before residing in a primarily English-speaking country ($p<.05$). Results are presented in Table 4. Overall, there is not a relationship between exposure to English and the magnitudes of the differences between English scores and native language scores.

Table 3. Difference Scores		
Variable	**Mean**	**Standard Deviation**
Verbal Memory	6.93	9.36
Visual Memory	1.10	15.00
Visual Motor Speed	2.82	3.89
Reaction Time	0.01	0.06
Impulse Control	-0.23	2.74
Cognitive Efficiency Index	0.11	0.13
Symptom Score Composite	-3.63	12.02

Table 4. Pearson Correlation Coefficient Values of Difference Scores to English Exposure, N=30		
Difference Score	**Years Living in English-Speaking Country**	**Years of English Education**
Verbal Memory	0.249	0.178
Visual Memory	0.163	0.164
Visual Motor Speed	-0.181	0.251
Reaction Time	0.269	-0.039
Impulse Control	-0.089	-0.021
Cognitive Efficiency Index	0.227	-0.129
Symptom Score Composite	0.212	0.029
* Statistically Significant Correlation ($p<.05$)		

Gender

Post-hoc analysis was conducted to look for an effect of gender on the magnitudes of the differences between English language test scores and native language test scores. A one-way ANOVA was performed on the five composite scores measuring cognitive functioning along with the Cognitive Efficiency Index and the Symptom Score Composite. The results failed to discover any interaction between gender and score differences ($p<.05$), as seen in Table 5.

Table 5. One-way ANOVA of Gender Interaction with Difference Scores						
Difference Score	**Gender**	**Mean**	**St.D**	**95% CI**	**$F_{(1,28)}$**	**p**
Verbal Memory	Male	7.50	7.84	0.45, 14.05	0.039	.846
	Female	6.73	10.02	2.29, 11.17		
Visual Memory	Male	1.00	14.07	-10.76, 12.76	0.000	.983
	Female	1.14	15.64	-5.80, 8.07		
Visual Motor Speed	Male	1.83	2.42	-0.19, 3.86	0.704	.408
	Female	3.19	4.29	1.28, 5.09		
Reaction Time	Male	0.01	0.07	-0.05, 0.06	0.004	.953
	Female	0.01	0.06	-0.02, 0.03		
Impulse Control	Male	-0.50	2.78	-2.82, 1.82	0.100	.754
	Female	-0.14	2.78	-1.37, 1.10		
Cognitive Efficiency Index	Male	0.13	0.16	0.00, 0.26	0.303	.587
	Female	0.10	0.12	0.05, 0.16		
Symptom Score Composite	Male	1.50	5.04	-2.72, 5.72	2.061	.162
	Female	-5.50	13.32	-11.41, .41		

CHAPTER V

DISCUSSION

The goal of this study was to investigate the effect that language has on scores of ImPACT, a neurocognitive assessment used for concussion evaluation and recovery tracking, in persons who are non-native speakers of English. With increasing numbers of foreign-born student-athletes participating in NCAA sports[12] and the importance of proper concussion management, determining the most accurate and reliable way to evaluate concussions despite language differences is essential. In a broader sense, considering how language and cultural factors affect numerous areas of athletic healthcare is vital to athletic trainers and physicians working with these individuals and this study aimed to explore one aspect of this interaction. The results of this study demonstrate that testing language does have an effect on ImPACT scores for those whose native language is not English. Two of the five composite scores representing cognitive functioning, Verbal Memory (VM) and Visual Motor Speed (VMS), demonstrated differences between English and the native language test. The Cognitive Efficiency Index (CEI), which is calculated based on a subject's speed and accuracy during the Symbol Match module,[32] also demonstrated a difference that is considered statistically significant. These results indicate that language plays a role in cognitive function as measured by the ImPACT test beyond tasks explicitly measuring verbal cognitive abilities. This agrees with previous studies that have proposed that language and cultural differences may influence neurocognitive test scores.[2-4,10,11]

The manner in which VM, VMS, and the CEI are scored by ImPACT provides some insight into the interaction between verbal and non-verbal cognition and helps explain why language differences can affect non-verbal tasks as well. The VM score is based on a subject's performance on three different modules during the ImPACT test: word memory, three letters, and symbol match. The three letters task is also one of the two tasks used to determine the VMS composite score.[32] Thus, language differences causing a change in performance on this task would affect VM and VMS scores. The symbol match module, in addition to making up one-third of the VM score, is also the sole determinant of the CEI.[32] A change in performance on this task would result in changes to both of these scores. Since one of two tasks determining the VMS score and the task used in CEI scoring are also used in calculating VM, we propose that these tasks involve some level of verbal cognition in addition to the non-verbal aspects.

Findings in this study suggest a verbal component to non-verbal cognition, as the difference in testing language affected numerous ImPACT scores in this study's non-native English speaking population rather than just verbal memory. With language being one important aspect of culture, this agrees with earlier research finding a link between culture and non-verbal skill performance on cognitive tests.[22] Neurocognitive assessments of non-verbal and visual-spatial tasks are still culturally dependent, with some research finding a larger cross-cultural difference on these tasks than on verbal tasks.[22] Since ImPACT is normed in the United States,[11] considering the effect of language and culture on scores for foreign-born student-athletes is crucial; testing in their native language whenever possible can eliminate language difference as a factor that can skew test scores.

Data analysis revealed that the magnitudes of the score differences between the English test and the native language test were not correlated with either of the indicators of English-language exposure used in this study: years of residence in a primarily English-speaking country and years of formal English education. Despite research showing significant gains in second-language ability during the first few years of education and/or living in a country with it as a

primary language,[23] the differences in ImPACT scores were not influenced even though the average time of residence in an English-speaking country was three years and the average amount of education was nearly seven and a half years. The lack of relationship between score difference and English exposure reveals that dissimilarities in scores on cognitive functioning measures based on testing language remain significant, even in test-takers with many years of experience with English as a second language. Due to this, obtaining baseline measures of true cognitive function on neurocognitive tests for non-native English speakers may not be possible when tests are conducted in English; accurate baseline scores require testing in a person's native language.

While the difference in the Symptom Score Composite based on testing language did not reach statistical significance, there is anecdotal evidence from the study supporting earlier research that establishes an effect of culture and language on both symptom experience and symptom reporting.[3,11] One study noted an effect of culture on pain perception, behavior, and manifestation of stress.[3] Another study, which specifically investigated the ImPACT symptoms checklist, found a clinically relevant change in composite score amongst English-speakers from two different cultures; they speculated that a difference in symptom terminology interpretation may have been a factor.[11] When language is added as an additional variable, the score change may be more pronounced. Research on experience of concussive symptoms across four different cultural groups discovered differences in symptom incidence and severity. They concluded that the presence or persistence of certain symptoms during post-concussive assessment may simply be due to cultural and linguistic differences.[3] With this, failure to understand certain terms on the symptom checklist or differing interpretations of the terminology may affect symptom reporting in non-native English speakers, a difference that would more likely be seen during post-concussive testing when test-takers would be more likely to experience the symptoms.

Recommendations

Based on the results of this study, we propose an important clinical recommendation for baseline ImPACT testing of student-athletes for whom English is not their native language. Due

to differences in ImPACT scores between the two testing languages, individuals should be tested in their native language whenever possible. However, this would be limited to those who speak one of the sixteen foreign languages in which ImPACT is currently offered. Conducting testing in a foreign language is easily accomplished when the test is accessed through the ImPACT Applications, Inc. Customer Center website; any language that is currently offered may be selected at the beginning of the test. Purchase of any ImPACT testing package allows access to the test in these additional languages; no separate purchasing is required. As there is no additional cost for the foreign language tests, testing non-native English speakers in their native language is feasible regardless of budgetary concerns. There should be few, if any, barriers to implementing native language testing for those whom it is appropriate.

The recommendation to test in the native languages of student-athletes persists regardless of how many years they have been living in an English-speaking country or taking English educational courses. If a test-taker considers a language other than English to be his or her native language, the test should be administered in that language if it is offered by ImPACT. Even though subjects in this study had a significant amount of experience with the English language, the fact that score changes between the English and native language tests were found illustrates that these differences are not eliminated even after years of English exposure. In terms of baseline testing, this indicates that there is no threshold or "cut-off" point in terms of language exposure amount, after which testing in English will provide an accurate measure of cognitive functioning.

Even though this study failed to find a significant difference in Symptom Score Composite between the two testing languages, anecdotal evidence and previous research suggest that clinicians should understand the effect that language may have on symptom reporting, especially in non-native English speakers. With symptom scores directly affecting return to play decisions after a student-athlete experiences a concussion, it is important to consider how a lack of English proficiency or symptom description familiarity may influence symptom reporting. Athletic trainers and others administering baseline or post-concussive testing should be aware that

student-athletes who do not understand a word used to describe a symptom may score it as a zero regardless of their actual experience of the symptom. For this reason, every effort should be made to have student-athletes take symptoms inventories in their own language, such as the one offered as part of the ImPACT test, or have someone available to explain what is meant by a symptom description if the test is taken in English.

Limitations

Several limitations existed within the study. Firstly, there is an inability of the researchers to ensure that subjects were putting forth their best effort during testing and being honest regarding symptom experience. To overcome this, healthy subjects with no apparent motivation to skew results with poor effort or lie about their symptom levels were used. Secondly, ImPACT Applications, Inc. admits they have no data regarding the reliability or validity of their test when conducted in a foreign language (Personal Communication, April 11, 2013). This limits interpretation and generalizability of the results of the study. In addition, the small subject size served as a limitation; not all of the foreign languages that are offered by the ImPACT test were used during research. Thus, our ability to generalize our results to all languages beyond those used in this study is limited.

Future Research

Based on the limitations of the current study, the researchers propose that the study be repeated with a larger subject size. In addition to providing further validation for the results found in this study, it may allow for more of the available languages to be tested. In turn, conclusions could be drawn regarding each particular language and its effects on ImPACT scores versus English testing. It is possible, for instance, that a larger difference in scores may be observed with languages that do not use the English alphabet since speakers of those languages may not be as familiar with the English letters. This may affect accuracy or speed during certain modules such as the Three Letters task.

Another area for future research concerns the long-term stability of ImPACT scores in foreign language testing. Research on ImPACT when taken in English has shown no substantial change in baseline scores when retested four months, one year, and two years later.[5,6] Since ImPACT Applications, Inc. does not have reliability data on their foreign language tests (Personal Communication, April 11, 2013), research to establish baseline score stability should be conducted.

This investigation involved studying differences between English language testing and native language testing for non-native English speakers in healthy subjects only. While a difference was found in baseline scores, further research should look at the magnitude of score difference between the two languages in subjects during post-concussive testing. It is possible that cognitive impairment due to the presence of a concussion could exacerbate any existing score difference. As previously mentioned, there may also be a larger magnitude of difference in Symptom Score Composite since subjects are likely to be experiencing more of the symptoms or at a greater intensity.

While the results of this study show an effect of testing language on scores of the ImPACT neurocognitive test in non-native English speakers, we are unable to generalize our results to any other concussion assessments. Our findings suggest that testing language may also affect scores on various other assessment tools, such as the SAC, the SCAT-2, and other computerized neurocognitive tests. With a lack of research in this area, we advocate for further studies investigating the role of language in concussion testing for non-native English speakers. This could also be projected out to the broader provision of healthcare for student-athletes with varying linguistic and cultural backgrounds. Research should focus on finding ways to improve cultural competence of athletic healthcare providers in order to more effectively care for a diverse population of student-athletes.

Conclusion

With collegiate student-athletes coming from increasingly diverse backgrounds, including speaking a primary language other than English, this study set out to determine the effect that testing language has on scores of the ImPACT test in non-native English speakers. Results demonstrate a significant difference in scores based on the language in which the test is administered so we propose that non-native English speakers should be tested in their native language whenever possible. In addition to providing a more accurate description of cognitive ability, it allows clinicians to provide a more culturally-aware healthcare service based on an individual student-athlete's linguistic background. With concussions having potentially serious long-term complications if not assessed or monitored appropriately, ensuring that baseline neurocognitive assessments are valid and reliable is of the utmost importance.

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APPENDICES

Table 1. Native Language of Subjects	
Language	**Number**
Spanish	10
Mandarin	7
Portuguese	2
Korean	2
Czech	2
Norwegian	2
French	2
Russian	1
Swedish	1
Japanese	1

Table 2. Paired Samples t-test, N = 30						
Variable	**Language**	**Mean**	**St.D**	**95% CI of the Difference**	**t**	**p**
Verbal Memory	English	82.10	8.72	-10.43, -3.44	-4.058	.000
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Visual Motor Speed	English	39.51	5.68	-4.28, -1.37	-3.982	.000
	Native	42.33	6.97			
Reaction Time	English	0.59	0.08	-0.03, 0.01	-0.677	.504
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Impulse Control	English	5.10	4.35	-0.79, 1.26	0.467	.644
	Native	4.87	4.09			
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Symptom Score Composite	English	16.30	20.96	-0.86, 8.12	1.655	.109
	Native	12.67	16.37			

Table 3. Difference Scores		
Variable	**Mean**	**Standard Deviation**
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Visual Motor Speed	2.82	3.89
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Difference Score	**Years Living in English-Speaking Country**	**Years of English Education**
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Reaction Time	0.269	-0.039
Impulse Control	-0.089	-0.021
Cognitive Efficiency Index	0.227	-0.129
Symptom Score Composite	0.212	0.029
* Statistically Significant Correlation ($p<.05$)		

Table 5. One-way ANOVA of Gender Interaction with Difference Scores						
Difference Score	**Gender**	**Mean**	**St.D**	**95% CI**	**$F_{(1,28)}$**	**p**
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	Female	6.73	10.02	2.29, 11.17		
Visual Memory	Male	1.00	14.07	-10.76, 12.76	0.000	.983
	Female	1.14	15.64	-5.80, 8.07		
Visual Motor Speed	Male	1.83	2.42	-0.19, 3.86	0.704	.408
	Female	3.19	4.29	1.28, 5.09		
Reaction Time	Male	0.01	0.07	-0.05, 0.06	0.004	.953
	Female	0.01	0.06	-0.02, 0.03		
Impulse Control	Male	-0.50	2.78	-2.82, 1.82	0.100	.754
	Female	-0.14	2.78	-1.37, 1.10		
Cognitive Efficiency Index	Male	0.13	0.16	0.00, 0.26	0.303	.587
	Female	0.10	0.12	0.05, 0.16		
Symptom Score Composite	Male	1.50	5.04	-2.72, 5.72	2.061	.162
	Female	-5.50	13.32	-11.41, .41		

Figure 1. CONSENT TO PARTICIPATE IN A RESEARCH STUDY
OKLAHOMA STATE UNIVERSITY

Study Title: Effect of testing language on ImPACT scores in non-native English speakers

Investigators: Ashley Ziniel; Graduate Student, Health and Human Performance Department; and Dr. Jennifer Volberding; 186 Colvin Recreation Center, Oklahoma State University, Stillwater, OK

Purpose: The purpose of this study is to determine the influence that testing language (English vs. native language) has on scores of a computerized test used to evaluate concussion in students for whom English is not their native/primary language.

Procedures: You will be asked to visit Room 206 (the computer classroom) of the Edmon Low Library at Oklahoma State University twice. On the first visit, you will be asked to read and sign an informed consent document and complete a language information questionnaire that are approved by the Oklahoma State University Institutional Review Board (IRB). Once the informed consent form and language information questionnaire have been completed, you will be asked to complete the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) in English on one of the computers in the classroom. This test will take approximately 25 minutes to complete and will involve a series of computer tasks designed to test your memory, speed, and reaction time. The instructions for the test will be given to you at the start of the test. When you finish the test, you will be asked to sign up for a time to complete the test for the second time. On your second visit, you will come to the same location (Room 206, Edmon Low Library) and complete the same test (ImPACT) again but this time you will be tested in your native language. This will conclude your participation in the study.

Risks of Participation: There are no risks involved in this study.

Benefits of Participation/Compensation: This study will provide useful information about the effect of language on concussion testing in non-native English speakers. This information will help medical professionals make decisions about concussion testing language when working with students and athletes that do not speak English as their native language. In addition, subjects who complete both rounds of testing will be entered into a drawing for one of four gift cards to a local restaurant in the amounts of $25, $10, $10 and $5 or for one of five cash prizes of $20. Names of winners will be randomly drawn after completion of the study and they will be contacted by email to claim their prize.

Confidentiality: The primary investigator (PI) will make all attempts to keep personal information confidential. Your language information questionnaire and ImPACT test scores will be identified only by a code unique to you; this information will not be linked to your name. Your signed consent form and language information questionnaire will be kept in a locked drawer in the advisor's (Dr. Jennifer Volberding) locked office. Your ImPACT scores will automatically be stored in ImPACT Application Inc.'s password-protected online database; this database complies with all applicable laws and statutes for data confidentiality and security. Only research personnel will have access to the records. The collected data will be saved as long as it is scientifically useful; typically, this is a period of five years after publication of the results. You will not be identified individually in data analysis. It is possible that the consent process and data collection will be observed by research oversight staff responsible for the safeguarding the rights and wellbeing of people who participate in research.

Contacts: You may contact any of the researchers at the following addresses should you desire to discuss your participation in the study and/or request information about the results of the study: Ashley Ziniel, Oklahoma State University, Stillwater, OK; ziniel@okstate.edu or Dr. Jennifer Volberding, 186 Colvin Recreation Center, Oklahoma State University, Stillwater, OK; jennifer.volberding@okstate.edu. If you have questions about your rights as a research volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078; (405) 744-3377, irb@okstate.edu.

Participant Rights: Your participation in this research is voluntary. There is no penalty for refusal to participate and you are free to withdraw your consent and participation in this study at any time, without penalty. The International Students and Scholars (ISS) Office will not be notified of who enrolls in and/or completes this study.

CONSENT DOCUMENTATION:

I have been fully informed about the procedures listed here. I am aware of what I will be asked to do and the benefits of my participation. I also understand the following statements:

I affirm that I am 18 years of age or older.

I have read and fully understand this consent form. I sign it freely and voluntarily. A copy of this form will be given to me. I hereby give permission for my participation in the study.

_____ _____

Signature of Participant Date

I certify that I have personally explained this document before requesting that the participant sign it.

_____ _____

Signature of Researcher Date

Figure 2. Pre-test Questionnaire for English Exposure

Study: Effect of testing language on ImPACT scores in non-native English speakers
Pre-Test Language Information Questionnaire

Subject:

Please fill out the following information sheet. If you have any questions or need clarification of what is being asked, please raise your hand and the researcher at the front of the classroom will come over to help you. All information on this questionnaire will be kept confidential.

1) How many years have you lived or studied in a country where the primary or majority language is English? Please round to the nearest half year (example: ½, 1, 1 ½, 2, 2 ½, 3, 3 ½)

_____

2) How many years have you taken classes on the English language (reading, writing, or speaking classes)? Please do not count classes you have taken while living in an English-speaking country. You may count classes you have taken in school, through a tutor, online courses, or through other language learning programs (such as Rosetta Stone). Please round to the nearest half year (example: ½, 1, 1 ½, 2, 2 ½, 3, 3 ½)

_____

3) Please generate your unique 8-digit ID code using the following formula: age, day of the month on which you were born, last 4 digits of your phone number. This number will be used to match this information sheet to your online test results so you must use the same code each time. For example, a 23 year old who was born on September 7th whose phone number is 418-555-1286 would have a code of 23-07-1286.

_____

When you have finished this information sheet, please raise your hand and the researcher will come collect this paper and set up the online ImPACT concussion test for you.

Oklahoma State University Institutional Review Board

Date:	Monday, October 21, 2013
IRB Application No	ED13167
Proposal Title:	Effect of Testing Language on ImPACT Scores in Non-native English Speakers
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 10/20/2016

Principal Investigator(s):

Ashley K. Ziniel
4599 N Washington St Apt 7(
Stillwater, OK 74075

Jennifer Volberding
180 Colvin Center
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI, advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Cordell North (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,

Sheila Kennison, Chair
Institutional Review Board

VITA

Ashley K Ziniel

Candidate for the Degree of

Master of Science

Thesis: EFFECT OF TESTING LANGUAGE ON ImPACT SCORES IN NON-NATIVE ENGLISH SPEAKERS

Major Field: Health and Human Performance – Athletic Training

Biographical:

Education:

Completed the requirements for the Master of Science in Health and Human Performance with an emphasis in Athletic Training at Oklahoma State University, Stillwater, Oklahoma in May, 2014.

Completed the requirements for the Bachelor of Science in your Kinesiology with an emphasis in Athletic Training at University of Wisconsin - Madison, Madison, Wisconsin in 2010.

Experience:

Graduate Assistant Athletic Trainer, Oklahoma State University, 2012-2014
Intern Athletic Trainer, Butler University, 2011-2012

Professional Memberships:

National Athletic Trainers' Association, 2009-Present