Cognitive Diversity and the Design of Classroom Tests for All Learners

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Abstract

It is well documented that many successful individuals are challenged by cognitive-based disabilities that impact their performance in school and on tests. While commonly believed to be related mostly to the constructs of processing speed or reading fluency, there are other aspects of cognition that affect how an individual interacts with the demands of a test. Moreover, it is not only students with disabilities who bring a range of cognitive considerations to the postsecondary environment. As the diversity rises in postsecondary settings in terms of older students, veterans, non-native speakers of English, and students who lack exposure to academic vocabulary, faculty members will experience greater differences in the cognitive diversity of their students with increased frequency. In order for faculty members to develop assessments that genuinely measure the knowledge and skills that are intended to be measured, an understanding of cognition as it relates to test taking is needed. Therefore the purpose of this article is to integrate research on cognition and test taking by providing disability service providers and faculty with an understanding of how cognitive traits impact test taking. This article begins with a discussion on the main aspects of cognition that influence test taking. We then provide an overview of those student populations that are on the rise, and the areas of cognition that these individuals most often struggle with in postsecondary classrooms. Next, this article outlines basic guidelines for transforming tests so that their design is just for all learners. We end with a proposed training series that disability service providers can offer faculty.

Keywords: Classroom assessment, cognition, disability, diversity, tests

The term "cognitive diversity" can be used to conceptualize the different cognitive traits each student brings to the learning environment. This diversity includes, but is not limited to, individuals with disabilities. While every individual has unique cognitive traits, research indicates commonalities amongst specific populations. For example, individuals with attention-deficit hyperactivity disorder (ADHD) have greater challenges with attention span, and individuals with dyslexia are usually stymied in the domain of reading. While adult students with learning disabilities, ADHD, psychological disorders such as depression, anxiety, and Post Traumatic Stress Disorder (PTSD) can exhibit differences in their ability to perform academic tasks, the same is true of other segments of the postsecondary population. Individuals without disabilities such as older students, culturally and linguistically diverse students, returning war veterans exposed to trauma or violence, as well as students from varying socio-economic backgrounds also bring a level of cognitive diversity to postsecondary institutions.

Current data surrounding postsecondary enrollment trends suggests that greater awareness, understanding, and responsiveness to cognitive diversity within post-secondary institutions is needed. The need to obtain postsecondary education for career opportunities in America is more critical now than ever (Carnevale & Desrochers, 2003), shedding light upon the high stakes associated with achievement at the postsecondary level. Not surprisingly, national data indicate that adults are heeding the need for further education and that their enrollment at postsecondary institutions is on the rise (Institute of Education Sciences [IES], 2010). The increase in general student enrollment is leading to greater cognitive diversity within classrooms and lecture halls. Specifically, survey data indicate a rise in the number of culturally diverse students and students with disabilities attending postsecondary institutions (IES, 2010; Newman, Wagner, Cameto, Knokey, & Shaver, 2010). During the 2003-2004 school year, 12.9% of the postsecondary student population self-reported being Hispanic; three years later (2007 – 2008) the percentage of Hispanic students rose to 14.1 (IES, 2010; Newman, Wagner, Cameto, & Knokey, 2009; Newman et al., Shaver, 2010). A similar trend was observed for those who self-reported as Asian/Pacific Islander, 5.9% to 6.6%, respectively. According to the IES 2010 report, which contains the most recently collected postsecondary enrollment figures by group affiliation, there were 2,154,000 students with disabilities enrolled in undergraduate studies during the 2003 – 2004 academic year. This number rose to 2,226,000 for the 2007 – 2008 academic year. While the overall percentage of students with disabilities compared to students without disabilities dropped by half of one-percent (.5), the total number of students with disabilities still increased.

If we assume that not all adult students with disabilities report having a disability or that others have undiagnosed disabilities, then these statistics may be underestimations of the diversity in our classrooms. Indeed, "fifty-five percent of postsecondary students who were identified by their secondary schools as having a disability did not consider themselves to have a disability by the time they transitioned to postsecondary school" (Newman et al., 2010, p. 12). While students may not report having a disability, research tells us that symptoms associated with disabilities, such as ADHD, language disorders, and learning disabilities remain over time and into adulthood (Mugnaini, Lassi, Giampeolo, Albertini, 2009; Norvilitis, Sun, & Zhang, 2010). In addition to adult students with diagnosed or undiagnosed disabilities, it is important to think about the cognitive diversity within a variety of populations including older students, those going back to school for a career change, adult students exposed to violence, such as military service men and women, and adult students from varying socioeconomic backgrounds. Clearly the face of the "typical" college student has become "not so typical."

Tests are inescapable for all students, particularly postsecondary students. In fact, tests are a substantial contributor to an adult student's letter grade and/or allocation of course credit. Additionally, test performance can either promote or inhibit access to other resources such as financial assistance and career enhancement (Goonan, 2003). Given that test performance makes a critical difference during and beyond postsecondary education, college and university faculty members must think carefully about how tests are designed. Disability service providers can be instrumental in fostering this awareness. Care must be given to ensure that tests not only measure the intended content area, but are also accessible to the wide variety of postsecondary students.

Considering the ever-growing body of diverse learners in postsecondary academic settings today (Ewell & Wellman, 2007), it is critical that we understand and integrate the research findings in regard to cognition and test taking. That is the purpose of this paper. In addition, the authors hope that the extensive bibliography at the end of the paper will provide disability services providers with access to a wide range of research findings, both for their own interest and learning and to help them satisfy faculty questions.

Test-Related Cognitive Demands

Some common types of postsecondary test formats include, but are not limited to, multiple-choice, true/false, fill-in-the-blank, short-answer written responses, diagram and/or label, and question and answer (Brookhart, 1999). While students and faculty alike are often familiar with these common test formats, the cognitive demands required to access, attempt, and complete these common tests are less widely understood (Rutkowski, Vasterling, Proctor, & Anderson, 2010). Recent research from the fields of neuropsychology and neuroscience has helped us to understand what is going on in the brain when it comes to learning and test taking (Gregg, 2010; Korbin and Young, 2003; Rose & Meyer, 2002; Sireci & Pitoniak, 2007; Thompson, Johnstone, & Thurlow, 2002). Moreover, there has been an increase in the amount of research on how learning disabilities and emotions, such as PTSD (Rutkowski, et al., 2010), influence test taking.

To help with conceptualization within the scope of this article, select test-related cognitive demands are presented in three categories. First, there are those cognitive demands that primarily influence *access* to the test: language comprehension, visual spatial skills, and academic fluency. Second, long-term retrieval and visual motor integration primarily influence the student's ability to respond to the test or demonstrate knowledge. We refer to this as *output*. Third, working memory, attention, and processing speed influence *both test access and test output*. We caution that there is a great deal of overlap and "back and forth" when it comes to cognitive demands, and that this framework is best applied when addressing test design (see Figure 1).

Cognitive Demands Associated with Test Access

Language comprehension. Language comprehension, or the ability to understand spoken and/or written language, is fundamental to accessing test content (Treiman, Clifton, Meyer, & Wurm, 2003). Within the context of test taking, language comprehension is different from the ability to accurately hear sounds in spoken words or the ability to decode or read text. Rather, language comprehension refers to the student's ability to understand what a professor is saying or asking for, be it in spoken or written form. Often difficulties can arise as the student may misunderstand directions or directional words. The ability to comprehend language in this vein may or may not be related to whether the language spoken in a class is native or non-native to the speaker; language comprehension differences can be found in both non-native speakers of English, as well as those with language disorders (explained later in this article). It is critical for faculty and other test authors alike to appreciate the importance of language comprehension because most, if not all, postsecondary tests require some level of language comprehension. That is, across all subject areas, including Chemistry, Biology, World Religion, and so forth, tests include written directions and specific problems posed through language, which are separate from technical and academic vocabulary.

Visual-spatial thinking. While language comprehension encompasses the verbal demands of tests, visual-spatial thinking is also needed to access tests. Visual-spatial thinking refers to the ability to perceive, analyze, synthesize, and think with visual patterns, including the ability to store and recall visual representations (Mather & Jaffe, 2002). In other words, visual-spatial thinking allows the student to make sense of and work with visual input. Visual-spatial thinking is separate from visual acuity (Fletcher & Currie, 2011). Some examples of visual-spatial demands required for test taking include filling in bubbles on Scantron® test forms, labeling parts of an image, graphing an equation, and recognizing patterns.

Academic fluency. Most tests require some combination of reading, writing, and/or math skills; therefore, a certain level of academic fluency is required to access tests. Academic fluency is the "ease and speed by which an individual performs simple to more complex academic tasks" (Mather & Jaffe, 2002). A common

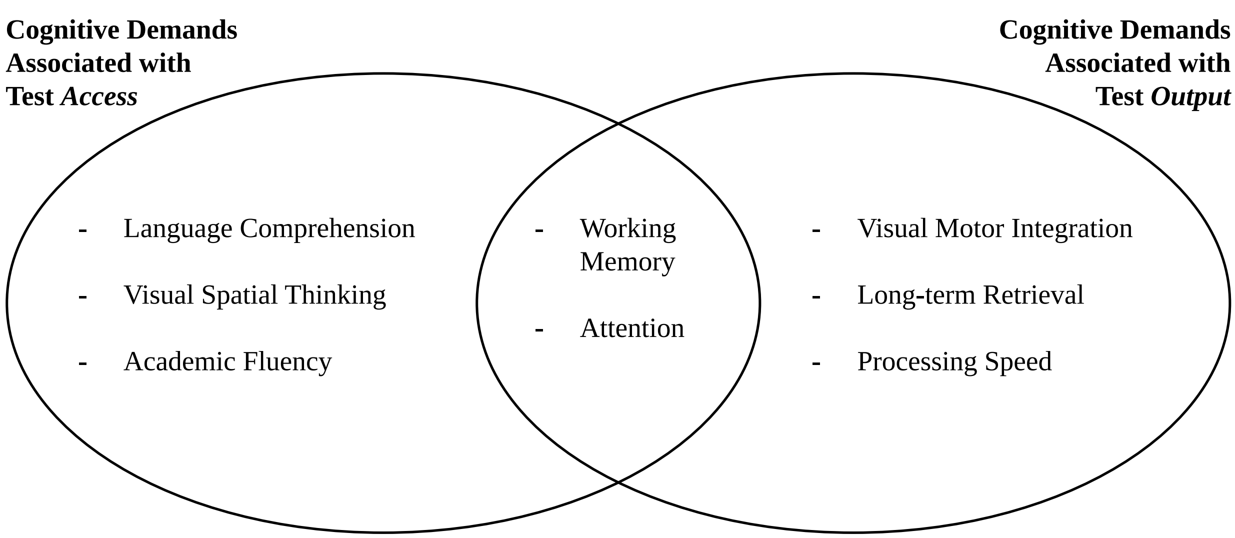


Figure 1. Cognitive demands associated with test taking.

mantra in education is, "First you learn to read, then you read to learn," the premise being that once a student masters foundational academic skills, then those basic skills serve as the foundation for deeper, richer learning. In the realm of a test, a student must be able to quickly read a test question, solve a simple equation, or spell words in order to have enough mental energy to think critically about the test content.

Cognitive Demands Associated with Test Output

Visual-motor integration. All tests require some form of output, be that giving a speech, writing an essay, executing pencil-to-paper calculations, or even running a mile. Assuming every postsecondary student takes tests that require written output, the cognitive demand of visual motor integration holds great weight. Specifically, visual motor integration is the ability to coordinate information from the eyes with body movements; "[it] is the degree to which visual perception and finger-hand movements are well coordinated" (Beery, Buktenica, & Beery, 2010). In turn, the cognitive demand of visual motor integration encompasses copying text, writing spontaneously, drawing a diagram, aligning numbers for a math calculation, filling in a bubble, circling an answer, and so forth. Christopher serves as an example. Christopher is a college-senior with dysgraphia, a learning disability which impacts handwriting legibility (Feifer & De Fina, 2002). For his sociology test, Christopher has to copy a demographics chart from the white board and then write an essay explaining the significance behind the chart. Christopher has to exert more mental energy than his classmates to visually comprehend the chart and then process this information through his fingers and onto the page (Beery, et al., 2010). Complicating matters, he also has to exert more mental energy or cognitive resources to form each and every letter (Feifer & De Fina, 2002).

Long-term retrieval. Ideally, tests assess mastery of course content by asking students to think back and demonstrate what they have learned. The cognitive demand of long-term retrieval refers to the ability to recall what was previously learned (Carroll, 1997). Long-term retrieval is two-pronged. One, the student must be able to accurately learn course material and store that information in memory, and, two, the student must be able to retrieve or "find" that information during the test (Mather & Jaffe 2002). Thinking of Christopher, he may have studied for several hours for his sociology test, but if he has long-term retrieval weaknesses, he may have to work harder to retrieve that information while writing his essay. The tip-of-the-tongue phenomenon is another good example. This phenomenon was first defined as an inability to retrieve a word even though there is a feeling of knowing the intended word (Brown & McNeill, 1966). Students with retrieval weaknesses often know course material, but cannot demonstrate that knowledge without prompting or cueing (e.g., multiple-choice tests).

Processing speed. Assuming that most postsecondary tests must be completed within a set time frame, processing speed is another core test taking demand. Indeed, many higher education tests are timed according the length of a class versus the purpose or function of the test (Ofiesh, Mather & Russell, 2005). While different researchers refer to the cognitive construct of speed in different ways (Ofiesh, 2000), processing speed, in a broad sense, refers to the ability to process or make sense of incoming information and to then produce a response (Carroll, 1997). Students with slower processing speed, whether due to a learning disability, depression, or other contributing factor, oftentimes do not finish tests within standard administration time, and use the most time on tests that involve math reasoning or math calculations (Ofiesh & Hughes, 2002). When students are unable to access an entire test due to limited time, then their test performance may be reflective of slower processing speed, among other constructs, and not an accurate measure of their understanding of the test content.

Cognitive Demands Associated with Test Access and Test Output

Working memory. Working memory is fundamental to test taking. Working memory refers to the ability to hold information in awareness while performing a mental operation or manipulation on the information (Levine & Reed, 1999; Mather & Jaffe, 2002). Moreover, working memory is "highly related" or central to all types of academic learning including reading, mathematics, written language, and reading comprehension (Dehn, 2008; Evans, Floyd, Mcgrew, & Leforgee, 2001). Unlike long-term retrieval, working memory focuses on recall while work is being done. To provide more clarity, examples are provided. Rebecca, a 24-year-old graduate student, reads the essay prompt for her course final. She must hold onto the content of the prompt while simultaneously reflecting upon information obtained during the course. To complicate matters and place heavier demands on working memory, she must then hold that information while thinking about the best way to convey her knowledge in written form. Another example of working memory demands during a test is offered. Miles is a 19-year-old college freshman taking his Calculus midterm. Miles reviews the first problem then begins to execute his calculations. Miles must perform each calculation step while simultaneously thinking about the next move, thus placing demands on his working memory (Feifer & DeFina, 2005). Of all the cognitive demands associated with test taking, working memory may be the most fundamental and multi-faceted (Swanson, 1994).

Indeed, Baddeley (2000) breaks working memory into a three-component system. The first component is the "phonological loop," which refers to holding and manipulating sounds or speech-based information while performing a mental operation. In Miles' case, he must use a verbal retrieval system for recalling basic math facts (e.g., 5 + 5 = 10) as he solves more complex calculations. The second component is the "visual-spatial sketch pad," which refers to holding and manipulating visual, spatial, and kinesthetic information in awareness in the form of visual imagery. Thinking about Miles again, if he needs to graph an equation for his midterm, then he will need to use his visual-spatial sketchpad as he works. The third component of Baddeley's working memory systems is the "central executive system," which controls the functions of phonological loop and visual-spatial sketchpad. This complex component system brings into focus the complexity and far-reaching aspects of working memory. That is, students with fewer working memory capabilities are likely to be challenged and taxed on a variety of tests, regardless of content area.

Attention. Similar to working memory, attention is critical to test taking. While attention is a seemingly simple concept, the neurological underpinnings required for us to pay attention are complex. In reality, attention requires selecting and focusing on what is important, maintaining that focus over a period of time, and filtering out or ignoring what is not necessary (McCabe, Roediger, McDaniel, Balota, & Hambrick 2010). Examples of attention demands for common postsecondary tests are provided.

One student, Anna, has significant depression, which impacts her concentration and attention. During her Anatomy course final, which includes several multiple-choice questions, Anna must pay careful attention to the questions; for example, multiple-choice questions with words or phrases such as *all, including, excluding,* and *best matches*. These require Anna's close attention not only to the content or purpose of the question, but also to discrete words. If Anna misses the word "except" due to inattention, then her answer may be wrong not due to a poor understanding of the material (e.g., anatomy of the lungs), but rather due to inattention. Jose is in Anna's course, and he too is taking the Anatomy final. Unlike Anna, Jose is an adult student with ADHD and has consequent difficulty filtering out extraneous visual input. Unfortunately for Jose, the lecture hall where the test is being proctored has several windows looking out onto a busy street. Jose must exert more mental energy than his peers to filter out or ignore the view of bustling cars and pedestrians, leaving less mental energy to demonstrate his knowledge of the human lung.

Exploration of Cognitive Diversity in Postsecondary Settings

It can be helpful for disability services providers and professors alike to better understand the cognitive diversity or specific cognitive traits students can bring to the learning environment. The following categories are discussed, with an understanding that there is great deal of overlap and comorbidity among them: learning disabilities, ADHD, language disorders, anxiety, depression, Post Traumatic Stress Disorder PTSD, Linguistic Diversity, Poverty, and Age.

Learning Disabilities. More and more students with learning disabilities are attending colleges and universities (Henderson, 2001). "Learning disabilities cross-culturally describe significant and impairing difficulties in reading, writing, and math domains" (Mugnaini et al., 2009, p. 255). Within the scope of this article, students with learning disabilities exhibit functional limitations in their ability to access and complete tests. "Deficits in speeded performance are one of the most common ways in which learning disabilities can impact an individual" (Ofiesh, Hughes, & Scott, 2004, p. 60). This is why extended time is often requested by individuals with learning disabilities in postsecondary settings. Indeed both processing speed and working memory impact test taking among students with learning disabilities (Gregg, 2010). Students with learning disabilities often need extended time on a variety of academic tasks such as organizing ideas when writing (Gregg, 2010; Ofiesh, et al., 2004), reading text (Jenkins, Fuchs, Van Den Broek, Espin, & Deno, 2003; Ofiesh, et al., 2004), and performing math calculations (Swanson, 1994).

Students with learning disabilities are also at a disadvantage when it comes to allocation of cognitive resources. Adult students with learning disabilities allocate their mental energy or cognitive resources differently than their same age, non-learning disabled peers when it comes to reading, writing, and math (Carroll, 1997; Feifer & DeFina, 2000; Meyer et al., 2001; Mugnaini et al., 2009). For example, students with reading disabilities, such as dyslexia, or poor readers in-general, must place heavier cognitive demands on word identification, thereby draining other cognitive resources needed to comprehend or construct meaning from text (Jenkins, et al, 2003; Ofiesh, et al., 2004; Torgesen, Wagner, & Rashotte (1997). Similarly, students with writing disabilities, such as dysgraphia, have to work harder and longer when it comes to handwriting (spontaneous writing and copying), spelling, and integrating capitals and punctuation (Berninger, 2008; Feifer & De Fina, 2002; Gregg, 2010). In turn, when tests require written output, students with writing disabilities have fewer cognitive resources available for demonstrating their concept mastery or knowledge (Gregg, et al., 2005). The same pattern is true for math. When students such as Miles have to exert extra energy to recall basic math facts, fewer cognitive resources are available for the intended test content (Feifer & DeFina, 2005; Swanson, 2004). Simply put, adult students with learning disabilities exhibit impairment in the test-related cognitive demand of academic fluency.

Attention Deficit Hyperactivity Disorder (ADHD). Research suggests a comorbidity or concurrence of learning disabilities and ADHD (Mugnaini et al., 2009). It is estimated that 2% to 8% of college students within the United States have ADHD (Weyandt & DePaul, 2006). This statistic does not reflect students with undiagnosed ADHD. This is noteworthy since Biederman and Faraone (2005) studied a group of 19-year-olds formerly diagnosed with ADHD and found that while 60% of the group no longer met full criteria for ADHD, 90% still presented with ADHD symptoms. Indeed, individuals with ADHD have life-long difficulties (Barkley, 1998; Barkley, Fischer, Smallish, & Fletcher, 2002), which underscores the need for support even at the postsecondary level. Adult students with ADHD exhibit impairment in the following test-related cognitive demands: attention, working memory, long-term retrieval, and processing speed (Barkley, 1997). As in Jose's case, he must exert more mental energy to filter out the comings and goings outside the window of his lecture hall. Moreover, Jose must work harder to sustain attention to the test over time, meaning that his cognitive resources are drained or taken away from the actual purpose of the test. For longer, more complex problems, fewer working memory resources can lead to small errors or mistakes, not reflective of poor course mastery, but rather of functional limitations associated with ADHD. Similarly, many students with ADHD exhibit weaknesses in the cognitive demand of long-term retrieval (Pollak, Kahana-Vax, & Hoofie, 2008).

Language Disorders. It is important to note that language disorders are different in nature and manifestation than academic difficulties sometimes associated with being an English language learner. However, for some individuals who struggle with language comprehension, English can function as if it were a foreign language, even if it is their native language. Individuals with language disorders exhibit impairment in comprehending and/or using spoken, written, or other symbolic language systems (American Speech-Language-Hearing Association, 1993, 2008). While about one million people in the United States have aphasia (partial or complete impairment of language comprehension caused by stroke or brain damage), many individuals attend school from early on with mild to moderate language comprehension difficulties and are considered to have language disorders (American Speech-Language Association, 2008). Fahey (2000) in a chapter on Oral Language Problems, states that "children do not outgrow language and learning problems. Rather, the problems change and manifest differently over time as demands increases in complexity" (p. 138).

Anxiety. Survey data indicates that approximately 18% of American adults have an anxiety disorder (Kessler, Chiu, Demler, & Walters, 2005). Students with ADHD and/or learning disabilities can experience anxiety (Mugnaini, et al., 2009). While many students with learning disabilities and/or ADHD may not meet criteria for clinically significant levels of anxiety, they do report increased scores on measures of anxiety (Maag & Reid, 2006; Nelson & Harwood, 2011a, 2011b). There is a wealth of research on the interplay between anxiety, clinical or not, and academic performance (Eysenck, Derakshan, Santos, & Calvo, 2007; Nelson & Harwood, 2011a, 2011b). Specifically, individuals with anxiety exhibit particular difficulty with the cognitive demand of long-term retrieval, working memory, and processing speed. As mentioned earlier, these are all critical components to test taking.

Depression. According to the World Health Organization (2004), depression is the leading cause of disability in the world. This is particularly noteworthy within academic settings because depression detrimentally influences cognitive functioning, academic achievement, (Mugnaini et al., 2009; Nelson & Harwood, 2011b), memory recall (e.g., long-term retrieval) and recognition (Burt, Zembar, & Niederehe, 1995; Maag & Reid, 2006; Mugnaini et al., 2009). Moreover, because depression impedes learning and achievement beyond LD itself, depressive symptomology among students with LD has implications for educational programming and assessment (Mugnaini et al., 2009). Specifically, because depression can influence alertness a depressed student may show impairment in the test-related cognitive demand of attention (Eysenck et al., 2007). There is also an interplay between depression and memory (Burt et al., 1995; Mugnaini et al., 2009), such that students with depression show impairment in the test-related cognitive demand of long-term retrieval.

Post Traumatic Stress Disorder (PTSD). Rutkowski et al. (2010) studied military personnel before and after war-zone exposure to ascertain the impacts of PTSD symptoms (e.g., intrusive thoughts, poor concentration, and hypervigilance) on test-taking. Indeed, these researchers found that posttraumatic stress symptoms have potential detrimental effects on standardized test performance. This is significant because over 1.5 million service members have been deployed to war zones (Rutkowski et al., 2010). A substantial number who return not only present with PTSD, but also with impaired cognitive abilities in processing speed, short-term memory and long term retrieval, as well as other areas of cognition (Tanielian & Jaycox, 2008). Moreover, many veterans return and pursue postsecondary education funded by GI bills (Rutkowski et al, 2002; Tanielian & Jaycox, 2008). If we assume that Rutkowski's findings map onto a percentage of the civilian population exposed to trauma or violence, then the need for tests that are designed for a broad array of cognitive diversity is all the more critical.

Linguistic Diversity

Within the United States alone, there are growing numbers of culturally diverse students, including English language learners (ELL) (Cartledge & Kourea, 2008). Also of importance, national data indicates that culturally and linguistically diverse students, including ELL students, have higher rates of school drop out, disproportionate representation in special education, and the lowest outcomes of all students (National Research Council, 2002). This unfortunate statistic calls even greater attention to the need for postsecondary educators to be aware of and sensitive to the cognitive diversity and consequent needs of this already underserved population of students. Much like students with language disorders, students new to the English language carry associated challenges into postsecondary education settings, specifically in regards to the test-related cognitive demand of language comprehension (Rasmussen, 2010).

Poverty

There is an expanding corpus of research discussing the relationship between poverty and education (Hernandez, 2011; Parish, Roderick, Grinstein-Weiss, Richman, & Andrews, 2008; Pfeffer & Glodrick-Rab, 2011). Sadly, educational outcomes for students with some family poverty experience are far from ideal. For example, "22 percent of children with some family poverty experience do not graduate from high school, a figure about three times greater than the 6 percent rate for children with no family poverty experience" (Hernandez, 2011, p. 7). Students who have experienced what some may consider impoverished or simply a background that is financially disparate from the majority of their postsecondary peers often have weaker academic skills (Hernandez, 2011). Specifically, they exhibit less developed literacy skills due, in part, to living in communities with less access to print, such as the lack of bookstores and libraries funded by local tax dollars (Neuman & Celano, 2001). In turn, this can impact the cognitive demand of language comprehension and academic fluency.

Age

According to the Center for Education Statistics (NCES), during the 2007-2008 academic year, 23% of the total postsecondary student population was age 30 or older (IES, 2010). Of note, older students are and have been returning to postsecondary schools in substantial numbers. In 2002 they were subsumed under the data category of "nontraditional" students, which includes students who delay enrollment, attend school part time, work full time, have dependents, are single parents, and so forth (IES, 2002). Research tells us that students who start postsecondary education not in the same calendar year as high school completion (IES, 2002) are going back to school in record numbers for additional education and training (Creighton & Hudson, 2002; Kim, Collins-Hagedorn, Williamson, & Chapman, 2004). With aging come changes in cognition, most notably short-term memory, and another type of memory known as episodic memory. These changes begin to appear in midlife, and are exacerbated with anxiety and depression (Craik & Salthouse, 2000).

In summary, given the intersection between cognitive diversity and test demands in higher education, there is an apparent need for creating and using tests that address the needs of all learners while staying true to what faculty members want to measure (Ofiesh, Rojas, & Ward, 2006). Further, when tests are designed in a manner that removes barriers to access and barriers to output, then tests can be considered more true measures of a student's concept mastery, knowledge, and skill set.

Putting Research to Practice: Service Providers and Faculty Have the Power to Change Test Design

Creating tests that are just, useable, and sustainable can be challenging given the rigorous teaching and research demands placed on faculty members. In hopes of helping and encouraging faculty members and service providers alike to embrace the creating of accessible tests, we pull from and add to recent research related to universal design and offer a three-pronged framework that focuses on (a) test presentation, (b) test output, and (c) test content. Specifically, we offer disability service providers recommendations to ensure that test presentation and test output are designed in a manner that maximizes accessibility and that tests are designed so as to allow for more valid assessment of a student's mastery and knowledge. Next, we offer recommendations that can be shared with faculty for their designing of tests. We conclude with a proposed Faculty Training Series that disability service providers can offer faculty as a means of encouraging and fostering test design that is useable for our increasingly diverse postsecondary student populations.

Recommendations for Service Providers

Many times the onus for ensuring that students with learning differences maintain equal access to curriculum and equal opportunity to demonstrate concept mastery on tests falls on the shoulders of disability service providers at university disability resource centers (Block, 2006; Cryer & Home, 2008; Embry, Parker, McGuire, & Scott, 2009). A common responsibility of disability service providers is to level the playing field for students with disabilities by re-formatting test material (e.g., changing a printed text into Braille). We refer to this process as designing test presentation. Simply put, test presentation is how tests appear or, better said, how students can take in test information. Rose and Meyer (2002) suggest "flexibility in presentation." Because most test material is absorbed and processed through visual and/or auditory channels, suggestions are provided to help service providers maximize test accessibility through effective visual and auditory design.

Test Presentation and Visual Design. In this era of ever-evolving technology that is empowering between individuals with and without disabilities, service providers can offer students computer-based tests designed to accommodate multiple representations of test content (Thurlow, Lazarus, Albus, & Hodgson, 2010). Visual design suggestions are provided (see Figure 2):

- Service providers need the ability to create digital text, which allows for the altering of font type and font size; the same is true for digital images (Rose & Meyer, 2002). In fact, larger font size (size 14 versus size 12) benefits students with and without disabilities (Fuchs, et al., 2000).
- Particularly for students with low-incidence visual impairments such as blindness, service providers need the technology and equipment to turn text into Braille (Laitusis & Attali, 2011).
- Visual content should be designed so that it is simple and not cluttered. Examples include avoiding using Roman numerals, which can be difficult to visually discriminate, allowing appropriate spacing between questions, and placing keys and legends directly under the text where they are to be applied (Anderson-Inman & Horney, 2007; Gaster & Clark 1995; Ofiesh, et al., 2006;).

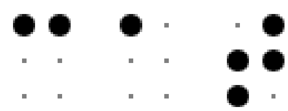
Test Presentation and Visual Design	
Font Size	cat, cat, cat
Spacing	cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat cat
Organization	Chart with key underneath
Braille	
Highlighting	cat cat **cat**

Figure 2. Test presentation and visual design.

- The National Center for Supported Electronic Text (NCSeT) has a list of "Typology Resources" (Anderson-Inman & Horney, 2007). Amongst others, they suggest "notational" resources. In other words, if a computer-based test is being offered, then the student should be able to make notations such as underlining, highlighting, or writing notes.

As a cautionary note, we cannot assume that all computer-based assessments are universally designed. For example, older students may be less familiar with computers, therefore taking computer-based tests potentially leads to more rather than fewer barriers for this group of students (Thompson, Johnson et al., 2002). To this end, there can be limitations in the accessibility of certain software and hardware. The above further underscores the need for "flexibility in presentation," such that computer-based tests should also be able to be presented in paper form. Moreover, older students may benefit from workshops or training in computer usage.

Test Presentation and Auditory Design. Similar to visual design, new technologies are improving the auditory design of tests. Several examples are provided:

- An accommodation for some students, such as students with learning disabilities in reading or visual impairments, is access to a reader (Sireci & Pitoniak, 2007). It can be costly and time consuming to have a human reader. Recent advances in text-to-speech software can be more cost-effective and support student independence. Also, there are software programs that read text aloud and simultaneously highlight the image of the text as it is being read; changes in speed, voice, and volume can also be made (Higgins & Raskind, 1997; See Table 1).
- Access to text-to-speech software can also be helpful with editing writing samples. For example, poor readers may have difficulty reviewing what they have written in order to make corrections. Similarly, students with limited attention may benefit from hearing and seeing their writing as a tool for editing. An empirical analysis by Garrison (2009) indicates that despite some other limitations, text-to-speech software can facilitate proofreading.

Table 1

Test presentation and auditory design

Test Presentation and Auditory Design	
Speed	The pace at which auditory information is presented to the student
Voice	Male or female, dialect, accent
Volume	Level of sound

Table 2

Gaster and Clark Eight Readability Guidelines

Gaster and Clark Eight Readability Guidelines (1995)

1. Use simple, clear, commonly used words, eliminating unnecessary words
2. When technical terms must be used, they should be clearly defined.
3. Compound, complex sentences should be broken down into several short sentences, stating the most important ideas first.
4. Introduce one idea, facts or process at a time; then develop the ideas logically.
5. All noun-pronoun relationships should be made clear.
6. When time and setting are important to the sentences, place them at the beginning of the sentence.
7. When presenting instructions, sequences steps in the exact order of occurrence.
8. If processes are being described, they should be simply illustrated, labeled, and placed close to the text they support.

Since most technology uses speech synthesis for either text-to-speech or speech-to-text, it is helpful to be cognizant of how to best use synthesized speech when transforming tests. In the postsecondary setting, this would most often occur when a faculty member decides to allow students to take a test via a computer with speech output. Cryer and Home (2008) found that the subjective acceptance of synthetic speech may depend on the users' experience, as people were found to "get used to" synthetic voices. The Centre's research also found that synthetic speech may be less intelligible than natural speech, particularly with background noise, and may need to be presented more slowly to be fully understood. However, measures of reading performance with synthetic speech improve with experience. Finally, some users of synthetic speech prefer less expressive synthetic voices as they felt it helped them to focus on the content of the text. This is important as it tells us a test may not be the best situation to try synthetic speech for the first time. Furthermore, headsets are warranted when tests are used with speech synthesis to eliminate background noise.

Test Output. Test output refers to how students demonstrate their knowledge on a test (e.g., handwriting, typing, drawing, or speaking). Test output is particularly critical because it is what faculty members use to grade and evaluate students. Disability services providers can supply students with alternate means for demonstrating concept mastery on tests. Examples and considerations are offered:

- Access to a computer for writing limits visual motor integration or graphomotor barriers. Moreover, when working on a computer students can more easily edit (e.g., cut, copy, and paste) their work versus having to erase and re-write.
- Speech-to-text (dictation) software allows students to dictate responses, limiting graphomotor and visual barriers. Dictation software should be implemented with care. Dictation software includes a learning curve. Advanced planning and practice is needed to ensure that the student has access to a dictation program that has been trained to process his or her voice.
- Allow students to document answers directly on the test booklet. Many times tests have separate components: a test booklet and a response sheet such as a Scantron. Separate components are inherently biased for students with poor visual motor integration (Thompson, Johnson et al., 2002). Moreover, students with attention weaknesses may lose their attention set while transferring answers from the test booklet to the Scantron or other response form.

Recommendations for Faculty Members

One role of faculty is to facilitate the acquisition of knowledge and skills within a given discipline. The reciprocal role of students is to prove mastery of that knowledge, typically by taking a test. As the creators and authors of tests, faculty have the power to design tests that accurately measure student knowledge without bias. Several suggestions are provided to facilitate faculty in designing test content that is sensitive to cognitive diversity within student populations.

Test Content. Test content refers to the meat or heart of the assessment; it consists of the course concepts that faculty want their students to master. According to Thompson et al. (2002, p. 8), "An important function of well-designed assessments is that they measure what they actually intend to measure." Accordingly, faculty should create tests that accurately assess course goals and objectives (Ofiesh, et al., 2006). The following factors should be taken into consideration to ensure that test content is accessible to as many adult students as possible:

- Avoid using irrelevant graphs or pictures (Ofiesh, et al. 2006),
- Verbal content should be clear, concise, and specific. Questions should be easy to understand regardless of the student's experience, knowledge or language skills, or current concentration levels (Thompson, Johnstone, et al., 2002).
- Advanced and technical vocabulary should be used only when it is part of the content to be measured, not as an exercise in verbosity (Ofiesh, et al., 2006).
- Directions and questions need to be in simple, clear, and understandable language. "Compound, complex sentences should be broken down into several short sentences, stating the most important ideas first… All noun-pronoun relationships should be made clear… When presenting instructions, sequence steps in the exact order of occurrence." (Thompson, Johnstone, et al., 2002, p. 14; Gaster and Clark, 1995).

- Test content should not be biased based on a student's socioeconomic status or experience outside of school (Thompson, Blount et al., 2002; See Table 2).

Faculty Training Series: A Tool for Disability Services Providers and Faculty

Faculty and disability service providers have a common goal: educating students. However, each brings different and equally valuable expertise and knowledge to a university. On one hand, a postsecondary faculty member is a master of his or her subject and has thorough training in the content area, and, in some cases, less direct training in pedagogy and teaching. On the other hand, a disability service provider has a background in disabilities, including how disabilities can impact learning. Both faculty and disability service providers are charged with the responsibility of not only designing accessible tests for all students, but also ensuring that test design is an accurate and valid estimate of a student's true mastery. Furthermore, valid test results from student exams can better inform a professor's potential need to modify/improve subsequent instruction.

Disability service providers have a wealth of information in terms of disabilities, functional limitations associated with disabilities, and necessary academic accommodations or supports. Dispersing or sharing this information during a phone conversation or over a chain of emails can be challenging. Disability service providers must then decide how best to share their knowledge with faculty members. Murray, Lombardi, and Wren (2011) conducted a survey on the effect of disability-focused training on university staff members, and their findings are encouraging. Their study included two key findings: (1) University staff who have received "disability-focused" training experiences in the past report more positive attitudes towards students with learning disabilities, and (2) 112 survey participants who had not received prior learning disability training expressed interest in receiving learning disability training and felt that they needed more knowledge in regard to how to support students with learning disabilities (Murray, Lombardi, & Wren, 2011). Given the inherent interest and need, we offer a model training series (see Tables 3 and 4).

There are always cases which engender more questions than answers. In these cases, ongoing collaboration between faculty and disability service providers is needed to ensure that individual needs are met.

Ofiesh et al. (2006) use the term "thoughtful assessment" to refer to assessments that serve both faculty and students in postsecondary settings. Specifically, thoughtfully designed tests measure intended content, allow faculty to evaluate their teaching, and are accessible to a variety of learners.

A thoughtful, universally designed assessment consists of a multitude of considerations, including, but not limited to, subject content, electronic flexibility, English language usage, format options (e.g., essay, short-answer), time limits, text characteristics, a direct link form the goals and objectives of the course, instruction, and informational delivery system, and more (Ofiesh et al., 2006).

Researchers at the National Center for Education Outcomes created a list of key elements of assessments that maximize access to a wide range of learners with varying cognitive characteristics (Thompson, Johnstone, & Thurlow, 2002). These elements are (a) inclusive assessment population (e.g., test design takes into account all types of learners: those who need large font due to aging, users of Braille, individuals with migraines who may want to adjust font and background colors on computer screens, etc.); (b) precisely defined constructs (e.g., what the test is designed to measure in terms of content, skills, knowledge base, and what one is required to be able to do to take the test are clearly laid out); (c) accessible, non-biased items amenable to accommodations (e.g., words with double meanings or that are more readily understood by males or females are eliminated); (d) simple, clear, and intuitive instructions and procedures (e.g., understanding how to take the test should not be part of what is being measured); (e) maximum readability (e.g., large font, adjustable foreground and background colors, speech output options, etc.); and (f) maximum legibility (e.g., options for use of speech recognition systems, scribe, adjustable font size, different paper options when needed).

What The Future Holds

Fortunately, research regarding how the brain works, learns, and responds and innovations in the field of computer technology are growing in parallel. Future studies are likely to inform and improve the creation and application of accessible tests, also allowing for greater test validity. Research tells us that the act of taking a test or, more specifically, the act of retrieving previously learned information, promotes

Table 3

Faculty Training Series: Designing Accessible Tests Parts 1 – 3

Part 1 Introduction to Disability Resource Center	**Part 2 Accommodations**	**Part 3 Accessible Test Design versus Accommodations**
Introduction: Universities can be worlds unto themselves with a breadth of programs and services. Introduce faculty and other staff to the disability resource center, including its staff, supports, and services. Additionally, many faculty and staff would benefit from a basic overview of the variations in learning processes among different types of learners.	Accommodations: Briefly review federal regulations that mandate that academic accommodations are offered to students who have a disability that obfuscates learning. Reinforce how accommodations, such as extended time or access to a computer, serve to level the playing field and provide equal access; they do not offer an advantage or leg-up. Documentation and Allocation of Accommodations: Given a lack of training, some may question the process behind determining who receives what accommodations and how much. Review documentation procedures and standardized testing standards. Time for a review in statistics; bring out the bell curve!	Accessible Test Design: Accessible test design can remove the need for many accommodations. Combat misperceptions. Example: Research tells us that extended time does not benefit individuals who do not need the time (Ofiesh & Hughes, 2002)

learning (Pastötter, Schicker, Niedernhuber, Bauml, 2011). Laitusis & Attali (2011) are studying computer-based tests that can eliminate a distracter and provide immediate feedback to the test taker. Moreover, Mills, Hansen, Laitusis, Slater (2011) are researching usability of reading items on various equipment such as the iPad and Netbook. While the continued development and implementation of accessible tests rests on faculty members and disability service providers, it is equally important that administration provide financial and systemic support (Rose and Meyer, 2002).

Table 4

Faculty Training Series: Designing Accessible Tests Parts 4 – 6

Part 4 **Promote "Thoughtful Assessment." Help faculty to understand the relationship between the goals and objectives of the course and how that translates into exam content.**	**Part 5** **Application- Review, revise, and redesign test content with a hypothetical example.**	**Part 6** **Application- Review, revise, and redesign test content with a personally created test.**
Inquire: Given a hypothetical science-based syllabus, ask participants what they think students should be able to do by the end of the course? *Nurture Insight:* What would a student need to show you in order to be able to demonstrate this competence to you? What are the goals and objectives in YOUR class? What would a student need to do to demonstrate competence in those areas? *Application:* Given a hypothetical test from the science course noted above, ask yourself if the test is a good measure in terms of content? Do YOUR tests match YOUR goals and objectives?	*Review:* Samples of non-accessible test content. *Revise:* Non-accessible test content. Provide a simple, uncluttered, and organized handout with examples and solutions for support. Use these ideas to foster redesign. *Redesign:* Tests to include accessible content. The challenge is to put research to practice and design tests that are accessible to the diverse population of postsecondary students. *Divide participants into small groups.	*Review*: Compare samples of non-accessible test content to a real test. *Revise:* Non-accessible test content. Share examples with others in a similar academic domain for input and more ideas. *Redesign:* Tests to include accessible content. Put research to practice and consider what else can be done to redesign your own tests that are accessible to the diverse population of postsecondary students. *Divide participants into small groups for feedback and sharing.

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