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W3C's Web Content Accessibility Guidelines (WCAG) has become the de facto legal standard for web design based on recent settlement agreements. The Department of Justice has even tried to make WCAG the actual law. This paper examines the most common plaintiffs in successful Americans with Disabilities Act (ADA) litigation against colleges and universities (individuals with visual impairments) and compares these plaintiffs to individuals with dyslexia, as both populations are covered under the ADA, as both populations have the same affected major life activity: reading. After identifying the 15 overlapping Success Criteria, this review then uses a systematic review methodology to determine when designing for individuals with dyslexia, then it also creates accessible webpages for individuals with visual impairments and when they do not.

Headings:

Accessible websites for people with disabilities

Libraries & the blind

Libraries & people with disabilities -- Standards

Libraries & people with dyslexia

Libraries & people with visual disabilities

Technology -- Information services -- Law & legislation

COMPARING DYSLEXIA AND VISUAL IMPAIRMENTS UNDER W3C'S WCAG: A LEGAL STANDARD FOR WEB DESIGN?

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Table of Contents

As libraries and information resources move into the twenty-first century, they are left without guidance on how to best provide information resources to individuals covered by the Americans with Disabilities Act as more and more resources are available exclusively online. Traditionally, libraries have looked towards the guidelines provided by the ADA in order to confirm that the library conforms to ADA requirements. Web resources have not had the same minimum requirements established the way that physical spaces have established minimum requirements. As the ADA has not created a minimum standard for web design, information providers, web developers, and advocacy organizations have had to find acceptable minimum standards without government intervention.

Americans with Disabilities Act

Congress passed The Americans with Disabilities Act (ADA) in 1990 (104 Stat. 327 (1990)). From the original passage of the ADA, the ADA has always required libraries (104 Stat. 327 Sect. 301(7)(h) (1990)), private schools from educational levels from nursery to post-graduate education (104 Stat. 327 Sect. 301(7)(j) (1990)), and institutions run by state and local government. Those institutions include public education from educational levels from nursery to post-graduate education, (104 Stat. 327 Sect. 201(1)(a)-(b) (1990)), to conform to ADA requirements. The ADA has always had broad definitions for disabilities, defined as having a physical or mental impairment which limits one more major life activities, (42 USC 12102(1)(A) (2012)) including reading and seeing (42 USC 12102(2)(A) (2012)). Because the ADA includes reading as a major life

activity, both individuals with dyslexia and individuals who are legally blind are covered underneath the ADA, and institutions that are defined under the statute have to provide access to these ADA covered individuals. For physical spaces, the ADA has had very clear definitions that libraries have had to follow. The ADA has recommended guidelines in inches for parking and passenger loading zones, maximum heights in inches of card catalogs, minimum widths in inches of library aisles or "stacks", and slopes of ramps (28 C.F.R. Appendix A to Part 36 (2010)). These specific guidelines provide clarity for libraries and other institutions to make their physical spaces accessible to relevant populations. Institutions have certainty that their physical spaces conform to minimum ADA requirements. This certainty does not exist when entering online spaces.

No legal standard for web accessibility as defined by the ADA has emerged at this point. The Department of Justice investigated making World Wide Web Consortium's (W3C) Web Content Accessibility Guidelines (WCAG) the legal standard in an Advanced Notice of Proposed Rulemaking (Nondiscrimination on the Basis of Disability, 2010). That guideline did not enter into the Code of Federal Regulations and was not enacted into law. However, the government and advocacy institutions have used W3C's WCAG as the de facto legal standards when suing universities to make electronic materials accessible (Youngstown State University Resolution Agreement, 2014; Resolution Agreement between University of Montana and the U.S. Department of Education, 2014; Settlement Agreement between the United States of American, Louisiana Tech University, and the Board of Supervisors for the University of Louisiana System under the Americans with Disabilities Act, 2013; Settlement Between Penn State University and National Federation of the Blind, 2011). Additionally, the ADA website,

hosted by the Department of Justice, does direct web designers to the W3C Guidelines for more information on web accessibility (Department of Justice, 2008).

Identifying Settlement Agreements for Information Resources

In order to find these settlements, a systematic review was conducted of the legal literature. The database Bloomberg, which includes all federal dockets, was searched. The search was limited to parties with the words "college" or "university: in the title of a party and then also limited searches to "Americans with Disabilities Act". That produced 48 results. Additionally, the Department of Justice's Office of Civil Rights' website of cases under "Disability Rights" was reviewed for settlements that were limited to university or college as a party to the action. The Department of Education's Office of Civil Rights' website also includes list of settlement agreements, and those were reviewed for disability rights cases. Finally, a general web search was completed to identify lawsuits where a university or college was sued for an ADA violation action. All lawsuits that fit those basic criteria were reviewed. The resulting cases were reviewed, and all cases that did not discuss electronic resources were eliminated. 6 relevant settlement agreements were identified (Youngstown State University Resolution Agreement, 2014 ("Youngstown State"); Resolution Agreement between University of Montana and the U.S. Department of Education, 2014 ("University of Montana"); Resolution Agreement: South Carolina Technical College System, 2013 ("South Carolina Technical College System"); Settlement Agreement between the United States of American, Louisiana Tech University, and the Board of Supervisors for the University of Louisiana System under the Americans with Disabilities Act, 2013 ("Louisiana Tech University"); Settlement Between Penn State University and National Federation of the

Blind, 2011 (“Penn State”); Settlement Agreement between the Regents of California and Disability Rights Advocates, 2005 (“UC Berkeley”)). Settlement agreements are often difficult to find. The discovery of six settlement agreements on this specific and narrow legal issue (where a college or university was sued for discrimination under the ADA and the settlement agreement discussed updating of electronic resource) was considered to be a successful search. In many instances of ADA discrimination, the judge either dismisses the case or grants a motion for summary judgment for the defendant. No settlement agreement is reached as the college or university had won in court with minor litigation costs.

Despite only finding six settlement agreements on point, the settlement agreements do appear to be representative. The settlement agreements have law suits brought by the Department of Justice’s Office of Civil Rights (“University of Montana”, 2014; “Louisiana Tech University”, 2013), the Department of Education’s Office of Civil Rights (“Youngstown State”, 2014; “South Carolina Technical College System”, 2013), and private advocacy organizations, like the National Federation of the Blind (“Penn State”, 2011) and Disability Rights Advocates (“UC Berkeley”, 2005). Of the six identified settlement agreements, four of the settlement agreements specifically used W3C WCAG as the required standard for web accessibility, and the settlement agreements required all four universities to make their electronic resources available to Level AA under the W3C WCAG (Youngstown State, 2014; University of Montana, 2014; Louisiana Tech University, 2013; Penn State, 2011). No other standard has emerged in settlement agreements with colleges and universities. As the settlement agreements use W3C’s WCAG, and the Department of Justice has tried to make W3C

WCAG 2.0 Guidelines a federal regulation for web content, W3C's WCAG appears to be the current de facto legal standard. This review will treat W3C WCAG Guidelines as the current legal standard. No other legal standard has emerged to guide content creators or web designers with making resources available to ADA covered individuals.

On the face, this emerging legal standard appears to apply only to libraries, but libraries are charged with purchasing electronic materials that best conform to W3C WCAG 2.0 Level AA ("University of Montana", 2014). Based on the purchasing requirements of the settlement agreements, it is anticipated that private, for-profit providers of electronic resources for colleges and universities will also have to use the W3C WCAG 2.0 Level AA guidelines when designing for disabilities. Some vendors have listed W3C WCAG 2.0 Level AA compliance on their websites under their accessibility description (Elsevier, 2015). While there is no evidence that providers of electronic resources have been sued by disability rights organizations, it is important to note that W3C WCAG 2.0 requirements have downstream use that affects other developers who have not been a party to litigation, such as private, for-profit providers of electronic resources for colleges and universities.

W3C WCAG 2.0 is meant to inform web design for users with *all* disabilities (World Wide Web Consortium, 2008). Individuals who have brought successful ADA lawsuits primarily have had visual impairments (Youngstown State, 2014; University of Montana, 2014; Louisiana Tech University, 2013; Penn State, 2011; South Carolina Technical College System, 2011). The question that needs to be asked is whether this standard actually seems to be working for individuals with other disabilities.

To determine this, a systematic review was completed which reviewed the W3C WCAG 2.0 in terms of its ability to address the needs of different groups of users Two disabilities were selected: visual impairment and dyslexia, as compatible disabilities who have the same major life activity, reading, limited under the ADA. The guidelines were then reviewed to determine instances of compatible, non-compatible, and incompatible design to determine whether W3C WCAG 2.0 Level AA actually create more accessible webpages for ADA covered individuals.

Defining Visual impairments

The Americans with Disabilities (ADA) covers disabilities that substantially limit at least one life activity, and includes both reading and seeing as major life activities (42 USC 12102(1)-(2) (2012)). Because the ADA's definition is so amorphous, many different kinds of visual impairments that limit seeing are included as covered ADA disabilities. Traditionally, Americans have limited individuals with sight disabilities to the blind. This definition historically has limited the blind to total blindness, which is the inability to perceive any light at all, (36 USC 83 (1934)) or light perception blindness, which is the ability to perceive light and nothing else (38 USC 723 (1934)). As society has evolved, the definition of visual impairments has expanded to include individuals with other visual impairments (e.g. individuals with visual acuity of 20/200 in the best seeing with corrective lenses) (42 USC 1382c (a)(2)(2012)). Individuals with visual acuity of 20/200 may qualify for federal support reserved for individuals with disabilities, such as Social Security payments (42 USC 1382(a) (2012)). From the legal literature, the ADA would cover, at a minimum, individuals with visual acuity of 20/200 or less. As the ADA focuses on substantial limitation of one life activity, this definition does not seem to

be the extent to which the ADA would cover individuals with visual impairments. Other individuals with limited sight include individuals who are described as having low vision. This definition is for individuals who have visual acuity of 20/40 best-corrected vision in the better-seeing eye (Congdon, et al., 2004). Low vision is considered a medical disorder and individuals with low vision find their reading ability limited, (Massoff, 2006) which is an impaired major life activity (42 USC 12102(1)(A) (2012). Additionally, the American Federation for the Blind has included individuals with low vision as part of their represented constituency (2015). As the definition of visual impairments for this paper was designed to be as inclusive as possible for web design, this paper will define individuals with visual impairments as individuals who have visual acuity of no better than 20/40 in the best seeing eye with corrective lenses. This definition includes individuals who have total blindness, light perception blindness, 20/400 visual acuity, and 20/40 visual acuity. This definition would include 100,00 Americans who have total or light perception blindness, approximately 937,000 Americans who have visual acuity of less than 20/400 as defined by the Social Security Amendments of 1972, and 2.4 million Americans who have 20/40 visual acuity for a total of approximately 3.5 million Americans (Warren, 1995).

Defining Dyslexia

Dyslexia is a reading disorder (Mather et al, 2011; McCarthy & Swierenga, 2010; National Institute of Neurological Disorders and Stroke (NINDS), 2011), covered underneath the ADA as a disability that limits major life activity (42 USC 12102(1)(A) (2012). Dyslexia is also learning disorder (NINDS, 2011), neurological or neurobiological disorder (International Dyslexia Association, 2015; Mather et al, 2011),

and a cognitive disorder (Beidas, Khateb, and Breznitz, 2013; McCarthy & Swierenga, 2010). It is estimated that symptoms of dyslexia may appear in as much as 20% of the population (International Dyslexia Association, 2015). For the purposes of IDEA, dyslexia is a cognitive disability (Vellutino, Fletcher, Snowling, & Scanlon, 2004).

In the web accessibility guidelines, W3C includes neurological disabilities as a type of disability that would benefit from accessible design, but none of the success criterion identifies neurological disabilities as a specific benefit of any success criterion (W3C 2008). Current medical literature refers to dyslexia most commonly as a neurobiological disorder. As neurological disabilities are wide ranging from dyslexia to dementia in terms of cognitive function, it would be insensible for W3C to identify neurological disorders as a general class experiencing a specific within the success criterion. However, it is important to highlight that W3C does not use most common medical classification (of neurobiological disorder) for dyslexia within its success criterion, at all. There are not currently any medical treatments to assist with dyslexia, and the National Institute of Neurological Disorders and Stroke instead advise modification of teaching methods to meet the needs of individuals with dyslexia (2011)

This paper treats dyslexia as a reading disorder. There is a suggestion in the medical literature that dyslexia correlates with process of visual information, but at this time, there is no definitive proof that limitations with processing of visual information is a symptom of dyslexia (Stein, 2014). Additionally, dyslexia correlates with reduced visual processing speed (Bogon, Finke, & Stenneken, 2014). Additionally, there has been some correlation with other forms of visual processing (Franceschini et al, 2012). The medical literature is uncertain about whether dyslexia causes or merely correlates with

other visual processing limitations. As this review is exclusively interested in whether W3C WCAG is a workable legal standard for individuals with dyslexia compared to individuals with visual impairments, this review only uses agreed upon symptoms from the medical community.

While professionals disagree on the definition of dyslexia, many authors agree that the following are symptoms of dyslexia:

> "Difficulty learning to rhyme words, the letter names and letter sounds of the alphabet. Confusions of letters and words with similar visual appearance (e.g., b and d and was and saw) and letters with similar sounds. Reversals and transpositions of letters and words that persist past the age of 7. Trouble arranging letters in the correct order when spelling. Difficulty retaining the visual representation of irregular words for reading and spelling (e.g., once). Spelling the same word in different ways on the same page and spelling words the way they sound rather than the way they look. Difficulty pronouncing some multisyllabic words correctly. Slow word perception that affects reading rate and fluency." (Mather, 2011, p. 7).

When examining whether W3C's WCAG fixes symptoms of dyslexia when processing web-based resources, the symptoms as identified by Mather are the definitive symptoms.

Methodology

Question presented: When using the W3C developed Web Content Accessibility Guidelines (WCAG) 2.0 for designing with individuals with disabilities, are there instances where designing for individuals with one type of disability makes the

electronically produced document or website less accessible for individuals with another disability? This review will compare individuals with dyslexia to individuals with visual impairments to find incidents of divergent design.

This review used a systematic review. This study takes the best practices from W3C WCAG to determine whether those best practices work consistently for individuals with dyslexia and individuals with visual impairments and asks whether best practices for individuals with dyslexia are consistent or inconsistent with best practices for individuals with visual impairments. While studies have been completed that use the language and identify best practices from the W3C WCAG, no study has started from WCAG and analyzed whether this is a workable legal standard under the ADA.

To answer this question, this study adapted the rules of the systematic review (Hemingway and Brereton, 2009) by following an adaption for information and library science (Vassilakaki and Moniarou-Papaconstantinou, 2015). As this study would otherwise be unmanageably large, this study limited individuals with disabilities to exclusively individuals with visual impairments and individuals with dyslexia. This was done for several reasons. First, individuals with visual impairments are currently the lead litigants when individuals sue colleges and universities for information technology resources (Youngstown State, 2014; University of Montana, 2014; Louisiana Tech University, 2013; Penn State, 2011). Because individuals with visual impairments are the lead litigants, this study wanted to compare a population with a similarly affected major life activity as covered by the ADA. When reviewing web content, both individuals with dyslexia and visual impairments qualify for coverage under the ADA under the same limiting major life activity, or reading. 42 USC 12102(1)(A) (2012). By examining

individuals with dyslexia and individuals with visual impairments, the same qualifying limited life activity was reviewed. The second reason that these populations were selected is because a vast number of Americans experience difficulties with both. It is estimated that up to 20% of Americans suffer from dyslexia (National Institute of Health, 2006). It is estimated that 20.6 million Americans (or 7% of the population) suffer from visual impairments (American Federation for the Blind, 2015). For the reasons listed above, this study limited the research to web design for individuals with visual impairments and dyslexia. Finally, both disabilities have a wide range of impacts on their constituent populations. Individuals with visual impairments can include people who have total blindness or light perception blindness (17 USC 121 (2012)), 20/40 vision in the best seeing eye (Cogden, 2004), or "trouble seeing, even when wearing glasses or contact lenses." (National Federation for the Blind, 2014). Dyslexia is a cognitive disability, a learning disability, and a neurological disorder. The two disabilities seem to affect a similarly number of populations under the same ADA major life activity and have stratified populations; this study compared those two populations.

Additionally, as this study attempted to find places of contrasting design within the W3C WCAG 2.0 framework, the search was limited to terms from W3C's WCAG. W3C WCAG 2.0 has 4 Principles, which guide web accessibility (W3C, 2015). Underneath the 4 principles, W3C identifies 12 guidelines, which form the basic structure for web accessibility (W3C, 2015). Finally, under each guideline, W3C identifies as many as 10 Success Criteria per guideline; these criteria are testable and specific design guidelines, divided into three levels of conformance, which are Level A, Level AA, and Level AAA (W3C, 2015). Finally, each success criterion has instructions on how to meet

the specific criterion and understanding the success criterion (W3C, 2015). Under each section entitled "Understanding Success Criterion X," W3C includes what kind of populations should receive benefit by adapting the specific Success Criterion. As one example, W3C states that Success Criterion 1.2.4 (which focuses on creating captions and its intended audience) benefits people who are deaf or have hearing losses but does not benefit individuals with visual impairments (W3C, 2015).

To determine which Success Criterion would be used, there was a two-step elimination process. First, Success Criteria at Level AAA were not included in this review, because current settlement agreements only require compliance with W3C 2.0 up to Level AA (Youngstown State, 2014; University of Montana, 2014; Louisiana Tech University, 2013; Penn State, 2011). Additionally, W3C does not advocate adoption of Level AAA as a universal standard as not all content can be satisfied to Level AAA (W3C, 2015). By limiting to Criterion to Level A or Level AA only, that reduced the number of Success Criterion for potential review from 61 to 38 for a total of 23 criteria at Level AAA.

As stated previously, it was recognized that not all Success Criterion would be relevant to either visual impairments or dyslexia. The previous example, Success Criterion 1.2.4, emphasized accessibility for individuals with hearing disabilities. Relevant terms were created which identified whether it would or could refer to visual impairments or dyslexia. W3C does not provide a definition for describing various disabilities. W3C divides accessibility categories into the following five major populations: (1) Visual Disabilities, (2) Hearing disabilities, (3) Physical disabilities, (4) Speech disabilities, and (5) Cognitive and Neurological Disabilities (Sevilla, et al, 2007).

W3C does not explicitly state who the guidelines are for and do not provide definitions, synonyms, or a controlled vocabulary for these or related disabilities. Because of lack of a controlled vocabulary from W3C, there was an attempt for wide inclusion for these terms. From the W3C "Understanding the Success Criterion," it was identified that W3C used the terms blind, visually impaired, low vision, vision disability, cognitive disability, learning disability, language disability, or reading disability underneath various "Understanding the Success Criterion" pages. We allowed the first group of terms (blind, visually impaired, low vision, or vision disability) as potential synonyms for visual impairments and allowed the second group of terms (cognitive disability, learning disability, language disability, or reading disability) as potential synonyms for dyslexia. No other W3C provided language seemed to be relevant to individuals with visual impairments or individuals with dyslexia. Finally, W3C would often use the term "assistive technology;" this term was included as a third category as individuals with visual impairments blindness or individuals with dyslexia could use relevant assistive technology.

After limiting each criterion to Level A or Level AA, Success Criterion were eliminated that did not include at least one vision-based disability (blind, visually impaired, low vision, or vision disability) or one cognitive-based disability (cognitive disability, learning disability, language disability, or reading disability). At this point, twenty-five potentially reviewable categories for individuals with dyslexia remained, and twenty potentially reviewable categories for individuals with visual impairments remained. Success criterion were eliminated that did not include a term for BOTH visual impairment AND dyslexia. The review was limited to the following 15 categories: (1)

"1.2.1: Audio-only and Video-only;" (2) "1.2.5: Audio Description (Prerecorded);" (3) "1.3.3: Sensory Characteristics;" (4) "1.4.3: Contrast;" (5) "1.4.4: Resize Text;" (6) "1.4.5: Images of Text;" (7)" 2.2.1: Timing Adjustable; "(8) "2.4.2 Page Titled;" (9) "2.4.4: Link Purpose;" (10) "2.4.6: Headings and Labels;" (11) "3.2.1: On Focus;" (12) "3.2.2: On Input;" (13) "3.2.3: Consistent Navigation;" and (14) "3.3.1: Error Suggestion;" (15) "3.3.3: Error Suggestions.'

Based on these 15 categories, a two-step inquiry was formed. The first inquiry was whether based the Success Criteria identified a specific problem area for the disability. The second inquiry focused on how experts believe that the identified problem area should be solved. The analysis then compared how the solutions for individuals with dyslexia compare to the solution for individuals with visual impairments.

After limiting to web design for individuals with dyslexia or individuals with visual impairments for the specific categories identified above, the review conducted searches on LIS databases LISA and ACM. As literature would appear in databases other than library science databases, we also searched Google Scholar and UNC's Article Plus. The reviewer searched using the search terms DYSLEXIA and WEB DESIGN; DYSLEXIA and W3C; DYSLEXIA and each Success Criterion (e.g., DYSLEXIA and 1.2.5; DYSLEXIA and AUDIO DESCRIPTION.) This search strings were then completed again with the words BLIND and LOW VISION and VISION DISABILITY replacing the word DYSLEXIA. Finally, as not all of best practices for web design would necessarily appear in website databases, disability rights organizations websites were reviewed to identify best practices for website designs for their respective populations (e.g., National Federation of the Blind.)

Inclusion/Exclusion Factors:

The research focused between 1994 and 2014, as few internet resources for the general public were available until 1994. This research did not limit exclusively to peer-reviewed papers, to allow for white paper inclusivity, but peer reviewed papers were prioritized. Additionally, if the study identified the language of the participants studied, only English language studies were used, as individuals with dyslexia may manifest symptoms in one language but not in another language (Vellutino, et al, 2004)

As the paper had a narrow focus and focused on the 15 Success Criteria, no additional exclusion factors were required. Additionally, we also reviewed white papers from advocacy and federal organizations, like the Department of Justice and the Department of Education (who are both responsible for ADA implementation), the National Federation for the blind, etc.

All published materials found in ACM Digital Library were included for review as there were only 453 results for W3C and BLIND; 102 results for W3C and LOW VISION; and 78 results for W3C and DYSLEXIA or DYSLEXIC, 1140 results for W3C and ACCESSIBILITY; compared to 7380 results for studies on W3C. Additionally, there were about 2000 studies on ACCESSIBILITY and BLIND or LOW VISION and 250 studies on ACCESSIBILITY and DYSLEXIA or DYSLEXIC. Additionally, we searched Google Scholar where a significantly higher number of dyslexia reviews were found than through the databases mentioned above.

Summation of Findings:

After reviewing the possibly relevant 15 Success Criteria listed above, the Success Criteria were divided into 5 categories, discussed below.

The first category was Unknown Success Criteria. This had one identified Success Criterion "1.2.5: Audio Description (Prerecorded)." As the medical research was uncertain whether processing of visual information was a problem with individuals with dyslexia, this criterion was identified as unknown. If the medical literature becomes more certain, it may make sense to later revisit Success Criterion 1.2.5 to review whether individuals with dyslexia have issues with processing of visual information.

The second category was called Irrelevant Success Criteria. This category identified Success Criteria that included the relevant labels to describe individuals with dyslexia and individuals with visual impairments. These Success Criteria were ultimately removed, because they did not specifically apply to individuals with dyslexia. "Success Criterion 1.2.1: Audio-only and Video-only (Prerecorded)" was removed, as text based resources are more difficult for individuals with dyslexia to process than image or sound based resources. Nothing in the medical literature indicated that individuals with dyslexia have difficulty processing audio based information, and the medical literature is uncertain whether individuals with dyslexia have difficulties processing visual information. Success Criteria under "3.2: Making web pages appear and operate in predictable ways", which included "Success Criterion 3.2.1: On Focus," "Success Criterion 3.2.2: On Input," and "Success Criterion 3.2.3: Consistent Navigation," were removed, as predictive ordering of text and websites do not appear to be specifically relevant for accessibility design for individuals with dyslexia.

After removing the previous five success criteria, ten success criteria remained which were relevant for accessibility design for both individuals with dyslexia and individuals with visual impairments. Those remaining relevant Success Criteria were the

following: “1.3.3: Sensory Characteristics,” “1.4.3: Contrast,” “1.4.4: Resize Text,” “1.4.5: Images of Text,” “2.2.1: Timing Adjustable,” “2.4.2: Page Titled,” “2.4.4: Link Purposes,” “2.4.6: Headings and Labels,” “3.3.1: On Input,” and “3.3.3: Error Suggestions.” These ten remaining Success Criteria were divided into the following three categories, below.

The third category was compatible design. This was defined as the following: when following this success criterion, the information resource became accessible for both individuals with dyslexia and individuals with visual impairments. Four Success Criteria (“1.4.4: Resize Text,” “2.4.2: Page Titled,” “2.4.4: Link Purposes,” “2.4.6: Headings and Labels”) were identified for this category.

The fourth category was non-compatible design. This was defined as the following: when following this success criterion, the information resource became accessible for individuals with dyslexia and did not become more or less accessible for individuals with visual impairments. Three Success Criterion (“2.2.1: Timing Adjustable,” “3.3.1: On Input,” and “3.3.3: Error Suggestions”) were identified for this category.

The fifth and final category was incompatible design. This was defined as the following: when following this success criterion, the information resource become accessible for individuals with dyslexia and became less accessible for individuals with visual impairments. Three Success Criterion (“1.3.3: Sensory Characteristics,” “1.4.3: Contrast” and “1.4.5: Images of Text”) were identified for this category.

Unknown Success Criteria:

Success Criterion 1.2.5

Success Criterion 1.2.5: Audio Description (Prerecorded) focuses on the creation of audio descriptions of visual information in a synchronized media presentation, like a video, which would include ". . . information about actions, characters, scene changes, and on-screen text that are important and are not described or spoken in the main sound track." (W3C, 2015). The specific benefit of Success Criterion 1.2.5 is for the blind or having low vision and for individuals with cognitive limitations who have difficulty processing visual information (W3C, 2015). As this Success Criterion, used terminology that this study described individuals with dyslexia (here "cognitive disability) and individuals with visual impairments (here "blind or low vision.") As such, this study originally included this Success Criterion in the review.

The medical literature is still unclear as to whether processing of visual information is related to dyslexia (Duranovic, 2014). Some research has shown that individuals with dyslexia have superior visual spatial processing ability (von Károlyi, et al, 2003) (The authors also identify additional studies that have shown individuals with dyslexia have superior visual spatial reasoning skills (Bannatyne, 1971; Hooper & Willis, 1989; Naidoo, 1972; Rugel, 1974; Sinatra, 1988; Swanson, 1984); that have shown individuals with dyslexia have inferior visual spatial reasoning skills (Bannatyne, 1971; Benton, 1984; Johnston & Ellis Weismer, 1983; Morris et al., 1998; Naidoo, 1972; Rourke, 1985) and that have shown individuals with dyslexia have comparable visual spatial reasoning skills (Koenig, Kosslyn, & Wolff, 1991; Rudel & Denckla, 1976; Rugel, 1974; Siegel & Ryan, 1989; Sinatra, 1988; Smith, Coleman, Dokecki, & Davis, 1977).) As the medical literature is inconsistent, but individuals with dyslexia may benefit from a prerecorded audio description if the medical literature later determines that

individuals with dyslexia have lower processing ability for visually presented information. Because of uncertainty in the medical literature, it is unknown whether 1.2.5 addresses a limitation caused by dyslexia. Until the medical literature becomes more certain, it seems unreasonable to use this criteria in the evaluation of whether this is a workable legal standard for ADA adoption. This was identified as an unknown as opposed to an irrelevant success criterion as medical literature may also require web developers to revisit this success criterion in the future.

Irrelevant Success Criteria

Success Criterion 1.2.1: Audio-only and Video-only

"Success Criterion 1.2.1: Audio-only and Video-only (Prerecorded)" is designed to help individuals with disabilities process either prerecord multimedia that is either video-only or audio-only. Individuals with dyslexia do not have difficulties processing the spoken language and can process speech at normal or ever faster rates than individuals without dyslexia (Elkind, 1998). As individuals with visual impairments are defined as having lower visual acuity of 20/40 in the best seeing eye, processing of audio only information is irrelevant for either population. While individuals with visual impairments would benefit from an audio description of video-only multimedia, the medical literature is still undetermined whether individuals with dyslexia have difficulties with processing of visual information (Stein, 2014). Until the medical community decides whether individuals with dyslexia have difficulties process visual information, this is not a currently relevant category for determining whether W3C is a workable legal standard for web design for multiple disabilities. As such, this Success Criterion was removed for review but if the medical literature does determine that individuals with dyslexia do have

difficulties processing visual information, then this category will want to be revisited to examine best practices for web design.

Success Criterion 3.2: Making web pages appear and operate in predictable ways

Guideline 3.2 focuses on "by presenting content in a predictable order from Web page to Web page and by making the behavior of functional and interactive components predictable." (Understanding WCAG 2.0, 2008). In the explanation of the Guideline, W3C focuses on accessibility technology like screen magnifiers, which is not an accessibility technology for individuals with dyslexia. While each of the success criterion worked with a disability for both individuals with dyslexia and individuals with visual impairments, ultimately it was discovered that Guideline 3.2, while using the language to describe the disability of dyslexia, did not actual identify areas for improvement for dyslexia. Guideline 3.2, which includes "Success Criteria 3.2.1: On Focus," "Success Criteria "3.2.2: On Input," and "Success Criteria 3.2.3: Consistent Navigation," was rejected for two reasons. First, as stated above, the medical literature is still discerning the extent to which individuals with dyslexia visual processing ability are limited by their disability, if it is limited at all. Second, the accessible technology that the Success Criterion described was not accessible technologies designed for or used by individuals with dyslexia. For these two reasons, these three Success Criteria were removed from analysis to determine whether W3C WCAG was a workable legal standard for the ADA.

All three of the success criterion used the language to describe the ADA covered disability that this study used to identify relevant criterion. Cognitive disability was identified as a possibly relevant term for individuals with dyslexia. Low vision was identified as a possibly relevant term for individuals with visual impairments. All three

success criteria used the minimum language to be included for review. Success Criterion 3.2.1 was originally selected as it affected individuals with cognitive disabilities and low vision. Success Criterion 3.2.2 was originally selected as it affected individuals with cognitive disabilities, reading disabilities, low vision, blindness, or visual impairments; Success Criterion 3.2.3 was originally selected as it affected individuals with cognitive disabilities, low vision, and blindness (Understanding WCAG 2.0, 2008). All three success criterion were included as possibly relevant criteria, given that they used words to describe the ADA covered disabilities this study hoped to identify.

Dyslexia does not appear to be a disability that has difficulties identifying organizational information or issues with layout. The medical literature is still unclear whether dyslexia correlates with visual spatial talents or limitations (Duranovic, 2014). Some studies have found that individuals with dyslexia do rely on the visual ordering of information in order to clarify meaning between objects (Bacon and Handley, 2010; Bacon and Handley, 2014). Other studies have indicated that individuals with dyslexia have decreased ability for spatial reference memory compared to individuals without dyslexia (Von Karolyi, et al., 2003; Winner, et al., 2001). Current literature seems to be trending in the direction that individuals with dyslexia do not have difficulties processing visual information.

T three specific Success Criteria do not identify relevant accessibility technology used by individuals with dyslexia. Here, of the three specific Success Criteria (Success Criterion 3.2.1 “On Focus”, Success Criterion 3.2.2: “On Input”, and Success Criterion 3.2.3 “Consistent Navigation”), none of them identifies specific pieces of accessible technology to be concerned about. Under “The Intent of Guideline 3.2,” W3C does

identify individuals who use screen readers as a population who many benefit from consistent design (W3C, 2015). Individuals with dyslexia may use screen readers to help them read information on the web (Fok, Miller Polgar, Shaw & Jutai, 2011; Bradbard, Peters, & Caneva, 2010; McCarthy & Swierenga, 2010; Elkind, 1998). However, the reason that individuals with dyslexia use screen readers to help synchronize the written word with sound, which also reinforces the written word with sound (Elkind, 1998). Guideline 3.2 is based in predictability to help navigate the website as a whole and not navigate the written word on the page (W3C, 2015). The Intent of Guideline 3.2 also discusses how individuals who use screen readers may also benefit from consistent navigation, as "screen readers present content as a one-dimensional stream of synthetic speech that makes it difficult to understand spatial relationships." (W3C, 2015). Individuals with dyslexia do not have difficulty understanding spatial relationships (von Károlyi, et al, 2003) and use screen readers to assist with language processing but not process of visual information (Elkind, 1998). As the described limitation of screen readers by W3C is not a limitation for individuals with dyslexia, this does not appear to be a relevant solution for individuals with dyslexia as this is not a relevant problem.

While individuals with dyslexia may benefit from consistent and predictable navigation, at this time, there is nothing in the literature or in the Guidelines that indicates that individuals with dyslexia particularly benefit from consistent navigation over individuals without dyslexia. However, it does appear that individuals with visual impairments may particularly benefit from consistent and predictable navigation over individuals without visual impairments. As the purpose of this paper is to identify areas of similarity or dissimilarity of design for individuals with dyslexia and individuals with

visual impairments, these three Success Criteria (3.2.1, 3.2.2, and 3.3.3) were removed after discovering that these three Success Criteria do not specifically benefit individuals with dyslexia.

Compatible Design

Compatible design was defined as the following: when designing for individuals with dyslexia, then it also creates accessible webpages for individuals with visual impairments. Four Success Criteria were identified as elements of compatible design for both populations. Those four Success Criterion were “1.4.4: Resize Text," “2.4.2: Page Titled,” “2.4.4: Link Purposes,” and “2.4.6: Headings and Labels”, discussed below.

Success Criterion 1.4.4: Resize Text

Success Criterion 1.4.4 instructs web develops to allow website visitors to resize text up to 200% of the original size (WCAG, 2015). In early studies on web font size, the smallest commonly used font size on the webpages was 9 point font (Ivory & Hearst, 2002), although the font size has appeared to increase to 10 point font as the web has become more ubiquitous (Ivory & Hearst, 2005). A regular print font is considered to be 12 point font (Kitchel, 2015).

The recommended font size for individuals with dyslexia is font size 12 or 14 (Rello, Kanvinde, & Baeza-Yates, 2012). When researchers have studied individuals with dyslexia and provided larger fonts than 12 or 14, then larger fonts has been preferred. Rello, et al., found that font size 26, which was the largest font size available for their study, was the preferred font size for individuals with dyslexia (2012a). A later study by Rello, Pielot, Marcos, & Carlini found no differences in preferences between font size preferred font sizes 18, 22, or 26 (2013).

Individuals with visual impairments appear to have similar font size constraints as individuals with dyslexia. A typical recommended font size is 12 or 14 for older adults (Bernard, Liao, & Mills, 2001). Large print books prepared by the American Printing House for the Blind use font sizes of 18, and the American Publishing House for the Blind considers individuals who need print sizes larger than 28 to be candidates for braille (Kitchel, 2015).

W3C WCAG Guidelines do not have any recommended font *sizes*, but merely a scaling percentage. Based on current or previous web practices with font size, a scalable font size of 200% from font size 9 or 10 would include the widest ranging preferred font size for individuals with dyslexia and individuals with visual impairments, as this would produce 200% scalable font sizes of 27 or 30 without losing website functionality. However, if web practices change and the minimum font size decreased to 8 point font, then the 200% scalable font would be font size 24 and would not include the upper end of preferred ranges for individuals with dyslexia and individuals with visual impairments. While this category, as currently written, is compatible for individuals with dyslexia and individuals with visual impairments, W3C WCAG should also include a minimum font size from which be scalable, because the scalability of the font does not help individuals with dyslexia or individuals with visual impairments if the original font size is 5 (and a 200% scalable font size dwould be 15).

Guideline 2.4 Navigable

Success Criteria "2.4.2: Page Titled," "2.4.4: Link Purposes," "2.4.6: Headings and Labels" were analyzed together. 2.4.2: Page Titled requires that the titles of webpages describe the topic (W3C, 2015). 2.4.4: Link Purposes requires that the purpose

of the link can be determined from the link text (W3C, 2015.) 2.4.6: Headings and Labels requires that the headings and labels of webpages describe the topic (W3C, 2015). The relevant Success Criteria under 2.4 are as relevant to issues of accessibility as they are to good web design (Kitchel, 2015). All three categories are included as these categories help individuals who use screen readers access the web (W3C, 2015). These characteristics are relevant as individuals with dyslexia and individuals with visual impairments may both use screen readers when accessing web pages (Fok, Miller Polgar, Shaw & Jutai, 2011; Bradbard, Peters, & Caneva, 2010; McCarthy & Swierenga, 2010; Elkind, 1998). As both populations may use screen readers, when a web designer designs for individuals with visual impairments and their use of a screen reader, then that web designer is simultaneously designing for individuals with dyslexia. As such, all three Success Criteria are compatible both individuals with dyslexia and individuals with visual impairments as they may use the same assistive technology when navigating the web.

Non-compatible Design

Non-compatible design was defined as the following: when designing for individuals with dyslexia, then it does not make webpages more accessible for individuals with visual impairments but also does not webpages less accessible for individuals with visual impairments. Three Success Criteria were identified as non-compatible. Those three Success Criterion were “2.2.1: Time adjustable,” “2.4.2: Page Titled,” “3.3.1: On Input,” and “3.3.3: Error Suggestions” discussed below.

Success Criterion 2.2.1: Timing Adjustable

Success Criterion 2.2.1 provides requires that time limits on web sites (1) can be turned off, (2) can be adjusted to at least ten times the length of the default setting, OR (3) have a warning at least 20 seconds in advance to extend the time limit unless (1) the time limit is because of a real-time event (like an auction,) (2) "the extension of the time limit would invalidate the activity", OR (3) "the time limit is longer than 20 hours." (W3C, 2015).

As dyslexia is an ADA qualifying disability because of limitations in reading, this section of the review assumes that the user of the website is required to interact with the written word on the website. As one example, if the website had time limits for processing of audio or visual information, nothing in the literature would indicate that a time limit would actually limit the ability of the individual with dyslexia to process the information. Dyslexia may need time extensions in order to process the written word. Individuals with dyslexia have a lower reading speed than individuals without dyslexia (Vellutino, et al., 2004). Some studies have shown that individuals with dyslexia have approximately a 15% slower reading speed than individuals without dyslexia (Rello, et al., 2012a).

As visual disability is an ADA qualifying disability because of limitations in reading, this section of the review assumes that the user of the website is required to interact with the written word on the website. Unlike individuals with dyslexia, individuals with visual impairments may also have difficulties accessing information contained in a video and may also need additional time in order to process that information as well. This review explicitly focused on the processing of the written word. Time limits pose difficulties for individuals with visual impairments, especially as they

access the web through screen readers or screen magnifiers (Fok, Miller Polgar, Shaw & Jutai, 2011; Bradbard, Peters, & Caneva, 2010).

The easiest way to be in compliance with this Success Criterion is to make time limits inapplicable (Alonso, Fuertes, Gonzalez, & Martinez, 2010). If this solution for this success criterion is to make time limits inapplicable on the website, then this success criterion is actually a compatible design criterion as opposed to incompatible design criteria. Most websites accessed with regularity do not have time limits, and, as such, are in compliance with this success criterion and the lack of a time limit is compatible solution for individuals with dyslexia and individuals with visual impairments.

Some websites, like websites with financial or educational records, do have time limits. For websites that do not have automatic time limits, no study has not been completed which indicates *how* to best implement time limits for individuals with dyslexia; it has just been noted that individuals with dyslexia need more time to access the same information when presented in the written word. No relevant studies were identified on accessibility and time limits. It is likely that a tactile response (like a pop up that the user selects to extend the time) is an acceptable form of web design for individuals with dyslexia as they do not have difficulties with processing of visual information, but no studies been conducted. One study was identified for mobile design, Koskinen found that audio feedback as an alert if a time limit was about to expire, produced more consistent responses (2008). The study has not been replicated or expanded upon. Until those studies have been completed, this review cannot say with certainty that Success Criterion 2.2.1 is a non-compatible design for individuals with dyslexia and individuals with vision disabilities, but symptoms of dyslexia would seem

that a tactile response with an auditory alert of a time out would be a compatible design for both populations.

Guideline 3.3: Input Assistance

"3.3.1: On Input" and "3.3.3: Error Suggestions" were discussed together, because "3.3.1: On Input" identifies is designed to show the user that an error had occurred and identify the error, while "3.3.3: Error Suggestions" identifies the error and then provides a suggestion to fix the error (W3C, 2015). W3C includes these as it has been discovered that individuals may abandon a form if they cannot identify the errors in the form (W3C, 2015).

Individuals with dyslexia reverse and/or transpositions of letters and words and may have difficulties arranging letters when spelling (Mather, 2011). In recent studies, individuals with dyslexia often twice as many phonological errors as individuals without dyslexia (Re & Cornoldi, 2015; Tops, Callens, Bijn, & Brysbaert, 2014). Phonological errors are the "when written word is pronounced differently than the intended target word" (e.g., *gangstser for gangster)" (Tops, et al, 2014, p. 297) and can be divided into four categories: insertions, omissions, substitutions, and transmissions. (Tops, et al, 2014). In English, it appears that phonological errors are the most common kind of error for individuals with dyslexia (Giannouli & Pavlidis, 2014). Individuals with visual impairments may use screen readers to access the forms and (Fok, Miller Polgar, Shaw & Jutai, 2011; Bradbard, Peters, & Caneva, 2010), and, for 3.3.1 may not notice the error until they encounter the error with their screen reader (W3C, 2015).

The suggestions that W3C lists would appear to help identify and suggest based on the closed fields that they describe. Here, W3C identifies errors like

> "the user fails to enter the proper abbreviation in to state, province, region, etc. field; the user enters a state abbreviation that is not a valid state; the user enters a non-existent zip or postal code; the user enters a birth date 2 years in the future; the user enters alphabetic characters or parentheses into their phone number field that only accepts numbers; the user enters a bid that is below the previous bid or the minimum bid increment."

(2015). W3C's suggestions for identifying the errors would be to highlight the missing field and to provide text description of the missing field (2015). To comply with "3.3.3: Error Suggestion," W3C suggests to list the acceptable values (listing the months of the year for a month field; or a text description (the words "Please provide the name of the month" for a month field) (2015). Error identification and error suggestion are not discussed much in the literature, and, if this were only for place for errors, in the kind of errors that W3C anticipates, then these two fields would be places of compatible design.

What makes them non-compatible design is that recent literature in the field of dyslexia research, as discussed above, has indicated that individuals with dyslexia make phonological errors more often than individuals without dyslexia and that phonological errors are the most common kind of error that individuals with dyslexia make in English (Re & Cornoldi, 2015; Giannouli & Pavlidis, 2014; Tops, et al., 2014). While the entering of text is not specifically a qualifying life activity under the ADA, the ability to identify and suggest errors because of content input makes web design more robust and accessible for qualifying populations. Individuals with dyslexia have difficulties both reading and writing, and web design has created tools to assist individuals with dyslexia from making spelling mistakes when filling out an open text field. For web design for

error identification and suggestion, the web can identify if the individual is making more errors than what is expected to be seen and can determine if those are phonological errors. A dictionary (American Wordspeller and Phonetic Dictionary) has been created which will spell check for individuals with dyslexia (Rello, Kanvinde, & Baeza-Yates, 2012b). It may be possible to integrate the dictionary with websites in order make error identification and error suggestion more meaningful for individuals with dyslexia, especially in responses that do not have fixed values (like months of the year.) More studies will want to be completed to confirm that phonological errors are the most common errors made by individuals with dyslexia and that these errors appear more frequently in individuals with dyslexia than individuals without dyslexia. There is enough evidence to suggest that if a web designer only designed for individuals with visual impairments and did not do more investigating than the two Success Criterion "3.3.1: On Input" and "3.3.3: Error Suggestions" may not be met for individuals with dyslexia. Here not identifying phonological errors does not make the experience worse for individuals with dyslexia, but it may limit their experience on the web.

Incompatible Design

Incompatible design was defined as the following: when designing for individuals with dyslexia, then less accessible webpages for individuals with visual impairments were created. Three Success Criteria were identified as elements of compatible design for both populations. Those three Success Criterion were "1.3.3: Sensory Characteristics," "Success Criterion 1.4.3: Contrast," and "1.4.5: Images of Text" discussed below.

Success Criterion 1.3.3: Sensory Characteristics

Success Criterion 1.3.3 is designed to provide instructions that do not exclusively rely on sensory characteristics such as size, shape, visual location, orientation, or sound (W3C, 2015). This is primarily for individuals with visual impairments. As with other categories, this focuses on vision based disabilities, and, as has been discussed, nothing indicates that individuals with dyslexia have limited visual spatial abilities. Dyslexia may correlate with limited sensory characteristics (Vellutino, et al., 2004) but is currently not identified as a symptom of dyslexia (Mather, 2011). However, it is important to highlight Success Criterion 1.3.3. In "Understanding the Success Criterion of 1.3.3", W3C acknowledges that information which uses visual spatial reasoning is an effective method for individuals with cognitive disabilities despite being a limiting method for individuals with visual impairments (W3C, 2015). While this is not a specific contrasting event for individuals with dyslexia and individuals with visual impairments, it is a contrasting event for individuals with cognitive disabilities, which W3C acknowledges. Here W3C advises that while information should comply with this Success Criterion, that compliance should not limit presentation of information in other ways (W3C, 2015).

Success Criterion 1.4.3: Contrast

Success Criterion 1.4.3: Contrast defines the recommended contrast ratio between the background and foreground as 4.5:1 (W3C, 2015). Both individuals with dyslexia and individuals with visual impairments have preferred contrast ratio. Individuals with dyslexia have different contrast sensitivity than individuals without dyslexia (Vellutino & et al., 2004; O'Brien, Mansfield, & Legge, 1999). Individuals with dyslexia have preferred colors of black text on a yellow background (Rello, et al., 2012a). Black text (000000) on a yellow background (color ffff00) has a color contrast ratio of 19.56:1

(WebAIM, 2015). Individuals with visual impairments prefer black text (000000) on a white background (FFFFFF) (Arditi, 2015). Black text on a white background has a contrast ratio of 21:1 (WebAIM, 2015). The preferred contrast ratio for individuals with dyslexia and the preferred contrast ratio for individuals with visual impairments pass the minimum requirements under 1.4.3, which is a minimum color contrast of 4.5:1 (W3C, 2015). The two preferred contrast ratios for each relevant population do not make it easier for the other population here. While this success criterion has created a reasonable legal guideline, the success criterion does not provide guidance for web designers when there are potential multiple color contrast ratios for populations with various disabilities.

Success Criterion 1.4.5: Images of Text

Success Criterion 1.4.5 Images of text requires that "text is used to convey information rather than images of text." (W3C, 2015). W3C further describes this Success Criterion to include "text that has been rendered in a non-text form (e.g., an image) in order to achieve a particular visual effect"; examples would include: a person's name on a nametag in a photograph, the periodic table, type samples, logotypes, branding, a facsimile of a handwritten letter, representation of a font family, etc. (2015.) The guideline requires that the text is used over the image of the text unless the presentation is essential, which W3C defines as fundamentally changing the information or functionality of the content, and the information or functionality could not be achieved through a conforming arrangement (W3C, 2015).

Individuals with dyslexia do not have documented difficulty processing visual information. Individuals with dyslexia are often visual learners and rely heavily on images, diagrams, and visual representations in order to understand materials that would

otherwise be presented through the written word (Rainger, 2003). Presenting information through images often helps individuals with dyslexia better process the information than they otherwise would through the written word. While individuals with dyslexia may use a screen reader in order to process the written information, they do not all use screen readers as a preferred accessible technology (Kitchel, 2015). Presenting images of text may simultaneously be more and less accessible to individuals with dyslexia, as individuals with dyslexia may prefer images to explain complicated text but then use a screen reader to access the information. Individuals with visual impairments, on the other hand, do have difficulties processing visual information, and, when possible, information should not be presented in an image or graphic (Murphy, 2005.) This Success Criterion requires the text to be used over images unless the image is essential to the information (W3C, 2015). A strict reading of this Success Criterion would limit the ability of the web designer and content creator to create materials that are more difficult for individuals with dyslexia to process. With some types of information, an image may not be the only way to present the information, which by definition would not be essential to the information. Here web designers and content creators have to determine the best way to make their information available to both populations simultaneously.

If the information is going to be presented visually to individuals with dyslexia and individuals with visual impairments, researchers have determined some ways to make the information accessible to both populations simultaneously. If images and image maps are used, then the web designer can instead provide redundant text links, (Evett and Brown, 2005), or text alternatives as spelled out in Success Criterion 1.1.1 (W3C, 2015; Murphy 2005). The image should be made available to print off the image for a tactile

printer (Gardner, Bulatov, & Kelly, 2009). In addition, web designers can use description links which would link to a page with an image of the description; they can also use a dotted decimal format for syntax diagrams (Murphy, 2005.) Without considering the alternatives, then visually presented information that would be more accessible to individuals to dyslexia may be sacrificed in order to comply with this Success Criterion.

Discussion

This study is attempting to determine whether W3C's Web Content and Accessibility Guidelines (WCAG) 2.0 works as the de facto legal standard for web design under the ADA and is doing this by comparing best design principles for individuals with dyslexia and best design principles for individuals with visual impairments. Because the medical literature is uncertain on whether processing of visual information is a symptom of dyslexia, it does not make sense to review those categories as comparable for the determining whether W3C's WCAG would work as a guiding legal principle.

This review used a systematic review methodology. Especially with dyslexia, researchers describe dyslexia itself in different ways and use different language to describe the best practices for web design, this reviewer is confident that not all studies were captured and does not assume such. This review attempted to capture all relevant studies for both populations using a systematic review methodology. Because of those limitations, this review is assumed to be a comprehensive, but not exhaustive.

Limitations

This paper is based upon broad definition categories. When defining individuals with visual impairments, this paper defined individuals with visual impairments as total blindness, light perception blindness, 20/400 visual acuity, and 20/40 visual acuity. This

paper assumed that all four categories of visual impairments were interchangeable as far as accessibility standards, but this is not necessarily the case. As one example, in the general structure, this study identified "Success Criterion 1.4.3: Contrast" as being a point of incompatible design because individuals with visual impairments and individuals with dyslexia have different color contrast requirements when reviewing websites. However, if the website catered to individuals with total blindness or light perception blindness, then the website's color contrast ratio would be a point of non-compatible design, as creating the color contrast for individuals with dyslexia would not make the website more or less accessible with total or light perception blindness as those populations do not rely on the coloration of the website in order to assist them with accessing the website. Additionally, this study also treated all four types of dyslexia as having them same design requirements. There is less literature in web design for each type of dyslexia. It is possible that, like individuals with visual impairments, individuals with different kinds of dyslexia may have different accessibility requirements. This study does not speak to this, but it does indicate that there is likely even further nuance and places of compatible, non-compatible, or incompatible design in different kinds of accessibility for the same disability.

W3C Standards

As can be seen under Success Criterion 1.3.3: Sensory Characteristics, W3C will identify Success Criterion where designing for individuals with one disability may make it the webpage less accessible for individuals with a different disability to access the same webpage. More research needs to be done to determine when using WCAG 2.0 to make websites accessible if it makes the website more accessible for other ADA qualifying

populations. Hopefully, this paper can provide a working guide for other individuals to study related ADA qualifying disabilities and determine if there are other instances of non-compatible or incompatible design.

Additionally, the W3C WCAG Working Group consists of volunteers from across the world, so researchers completing disability studies or representatives from disability organizations should become members of the working group in order to help make the WCAG more robust and representative of more ADA qualifying disabilities. As this review has indicated, W3C has identified robust web design for individuals with visual impairments but web design for individuals with dyslexia has been more limited. Reexamining Success Criterion 1.4.3, WCAG could list the preferred color contrast for individuals with dyslexia compared to individuals with visual impairments. While designing for either population meets the requirements of the Success Criterion, designing for one population makes it less readable for the other. Without knowledgeable experts of various ADA qualifying disabilities, one should not expect to see WCAG include these kinds of recommendations or explanations. Those recommendations make the guidelines more meaningful and robust as a universal web design document for all ADA qualifying populations.

Conclusion

Without some limitations, W3C's WCAG should not be made the minimum acceptable requirement for the ADA under the law as was originally proposed (Nondiscrimination on the Basis of Disability, 2010). When comparing only individuals with dyslexia to individuals with visual impairments, three Success Criteria were found to be incompatible with the other ADA covered population. If this became the legal

standard without some editing, it appears that there will be times when individuals with dyslexia or individuals with visual impairments would not have an accessible design for the website for their specific disability as the website would be designed for the other population. Additionally, three other criteria were found to have instances of non-compatible design. For the purpose of the web designer or content creator, this means that web designers or content creators could design the website thinking that web site is W3C WCAG compatible, and the website is not, because it does not meet the requirements for both populations. Here, the guidelines and accessibility checkers would need to identify these errors before the web developers and content creators were certain they were following the correct orders. At this time, it appears that these guidelines should stay as the de facto legal standard research is being done to continue to determine how best to design for ADA covered populations.

That being said, W3C WCAG is the de facto legal standards for web design, and currently the only robust standard that exists. As stated above, colleges and universities are being required through settlement agreements to update their websites using the W3C WCAG. When colleges and universities have to make a decision about whether to make their website accessible for individuals with dyslexia or individuals with visual impairments, current incentive structures make choosing visually impaired-friendly design over dyslexia-friendly design a safer choice for colleges and universities." Currently, individuals with visual impairments are the plaintiffs in successful ADA litigation, (Youngstown State, 2014; University of Montana, 2014; Louisiana Tech University, 2013; Penn State, 2011) and individuals with dyslexia do not appear to be parties to successful litigation. As stated above, many of the Success Criterion are either

points of compatible design or non-compatible design, so very few Success Criteria require decisions to be made to determine whether colleges or universities should design for individuals with dyslexia or individuals with visual impairments. As many Success Criterion are instances of non-compatible design instead of incompatible design, universities, colleges, and private companies that provide electronic information to colleges and universities should realize that when they design for individuals with visual impairments, they have not designed for individuals with dyslexia even if they were to use an accessibility checker which confirmed that they have designed for a specific success criterion. As research continues, colleges and universities have to stay abreast as the medical community identifies new symptoms of ADA covered disabilities and learn how to design based on those symptoms.

Appendix 1: PubMed Systematic Review Search Terms

dyslexia predictability
dyslexia AND "predictable content"
dyslexia predictable content
dyslexia AND "font size"
dyslexia AND "spatial information"
dyslexia AND "visual information" AND (hasabstract[text])
dyslexia audio AND (hasabstract[text])
dyslexia audio description AND (hasabstract[text])
dyslexia visual attention AND (hasabstract[text])
dyslexia cognitive AND (hasabstract[text])
dyslexia AND "reading disorder" AND (hasabstract[text])
dyslexia reading
dyslexia w3c
dyslexia web

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