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Audio-Supported Reading and Students with Learning Disabilities

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Audio-Supported Reading and Students with Learning Disabilities

Today, nearly half of all students receiving services under the Individuals with Disabilities Education Act (IDEA) are classified under the category of “specific learning disability” (OSEP, 2014). The vast majority of these students struggle with the process of learning to read (Cortiella & Horowitz, 2014). Since so much of the curriculum is made accessible to the general school population through print, difficulties with decoding, connecting, or deriving meaning from printed text can severely restrict student involvement in instruction and consequently hinder academic achievement. Undoubtedly, the process of learning to read and make use of printed text remains a serious and widespread challenge for many children as well as their teachers and families. While acknowledging that notable progress has been made in addressing this problem through early identification and prevention, diagnosis and remediation, and the use of technologies for compensation, this paper focuses on compensation through the use of audio supports. Ultimately, any code regularly available to the senses such as braille or print text must be perceptually decipherable in order for that code to be processed as language. Thus, the end goal of reading is the comprehension of intended meaning contained in and conveyed by language. Audio supports serve to substitute for or blend in with orthographical representations of text not readily or completely available to the reader. The degree to which audio supports work, in effect, will depend on the language processing capabilities of the reader—independent of sensory modality. Difficulty with deciphering and making use of text can reside anywhere along a continuum from sensory registration to elaborate schema construction in long-term memory (Daneman & Merikle, 1996; Fletcher, Lyon, Fuchs, & Barnes, 2007). With widespread availability of text-to-speech applications and digital content, a temptation exists to recommend learning through listening as a wholesale solution for everyone who struggles with reading. Hopefully, this paper will assist both consumers and practitioners with the process of determining when, where, and for whom audio supports are most beneficial.

Introduction

This paper provides an introduction to the concept of audio-supported reading (ASR) for students with specific learning disabilities. In a previous paper written for the National Center on Accessible Instructional Materials (AIM Center), Jackson (2012) defined ASR as a technology-based technique for reading in which individuals read digital text *in conjunction with* listening to the text in an audio format such as text-to-speech (TTS). A

video demonstration of ASR with computers, tablets, and smartphones can be viewed at Audio-Supported Reading page on the AEM Center site. While this earlier work focused on ASR in relation to students who are blind or have low vision, here we expand the discussion to include students with specific learning disabilities.

Part I of this paper describes the evolution of the concept of "specific learning disability" under the Individuals with Disabilities Education Act (IDEA) of 2004. Part II discusses the ways in which accessible educational materials (AEM)[1] can be used to support specific reading-related needs of students with learning disabilities. Part III provides a summary of ASR technique and examines the limited research pertaining to ASR and students with learning disabilities. Finally, Part IV presents key considerations for future work in this area.

I. Evolution of the Concept of "Specific Learning Disability" under IDEA

The term "learning disability" was first proposed by Dr. Samuel Kirk, professor of special education at the University of Illinois, in the early 1960s to facilitate communication between and among families and school-based personnel. In 1962, Kirk defined the term "learning disability" as follows:

> *A learning disability refers to a retardation, disorder, or delayed development in one or more of the processes of speech, language, reading, spelling, writing, or arithmetic resulting from a possible cerebral dysfunction and/or emotional or behavioral disturbance and not from mental retardation, sensory deprivation, or cultural or instructional factors (quoted in Kavale & Forness, 1995).*

The following year, in a speech before a group of parents, Kirk (1963) again used the term "learning disabilities," calling into question the usefulness of medical labels such as "brain injury, minimal brain damage, cerebral palsy, cerebral dysfunction, organic drivenness, organic behavior disorders, psychoneurological disorders, and a host of

[1] On September 30, 2014, the AIM Center concluded its funding cycle and the work of the National Center on Accessible Educational Materials for Learning (AEM Center) began. The term ''accessible educational materials'' (AEM) refers to print- and technology-based educational materials, including printed and electronic textbooks and related core materials, that are required by SEAs and LEAs for use by all students, produced or rendered in accessible media, written and published primarily for use in early learning programs, elementary schools, or secondary schools to support teaching and learning. Additional clarification regarding AEM is provided below.

other terms" (quoted in Kirk & McCarthy, 1975). These previous designations tended to obscure meaning and to alienate parents and educators.

In 1968, the National Advisory Committee on Handicapped Children (NACHC), chaired by Kirk, proposed a definition of the term *learning disabilities* that was consistent with Kirk's earlier definition (U.S. Office of Education, 1968). A similar definition was subsequently incorporated into Title VI of the Elementary and Secondary Education amendments of 1970 (Pub. L. No. 91-230, Title VI, § 602(15), 84 Stat. 121, 177 (1970)). While Congress enacted the Children with Specific Learning Disabilities Act of 1969, with the passage of the Education for All Handicapped Children Act of 1975 (EAHCA), the precursor to IDEA, the term "specific learning disabilities" was made into a formal disability category with respect to eligibility for services (Pub. L. No. 94-142, §§ 602(1), 602(15), 620(b)(4)(A), 89 Stat. 773, 775, 794 (1975)). In 1977, the U.S. Department of Education finalized the definition and it has remained essentially unchanged since that time (42 Fed. Reg. 65083 (1977)).

The current definition of "specific learning disability" under IDEA maintains elements of Kirk's original definition of learning disabilities as follows:

> Specific learning disability—*(i)* General. Specific learning disability *means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia (20 U.S.C. § 1401(30)(a); 34 C.F.R. § 300.8(c)(10))*.

Since the coining of the term *learning disability* in the early 1960s, a legacy of practices in special and remedial education have been dedicated to correcting or remediating learning challenges by relying heavily on measures of learning capacity (IQ), in part to distinguish learning disability from mental retardation (currently referred to as "intellectual disability") (Hallahan, Pullen, & Ward, 2013). Thus, a learning disability has been evidenced when a significant discrepancy is observed between an individual's potential (measured intelligence) and that individual's measured academic achievement, as long as intelligence falls within an average or above average range. Further refinements to the definition exclude other possible reasons for underachievement such as emotional disturbance, sensory impairment, or poor education.

Measures of general intelligence over the years, however, have become less relevant for eligibility for services and placement decisions under IDEA (Torgesen & Wagner, 1998). Today, many favor abandonment of an IQ/achievement discrepancy approach in

favor of one that relies on direct measures of student academic performance and progress (O'Connor & Sanchez, 2011; Vellutino, Scanlon, & Lyon, 2000). The time required to accrue measurement(s) of a significant discrepancy between IQ and achievement has been referred to as a "wait to fail" approach that neglects struggling learners at the optimal time of instruction when they are most likely to benefit from increased support from school personnel (Fuchs & Fuchs, 2006). Moreover, norm-referenced estimates of intelligence have proven increasingly problematic in meaningfully diagnosing capacity among culturally and linguistically diverse student populations (Abedi, 2006).

Because of the concerns over the utility and accuracy of standardized tests of general aptitude, the identification and diagnosis of specific learning disability has moved away from standardized measures of potential and achievement in favor of more direct measures of academic progress over time.[2] The 2004 re-authorization of IDEA states that when making a determination as to whether a child has a specific learning disability, a local educational agency (LEA) must not be required to take into consideration a severe discrepancy between achievement and intellectual ability and may use a process that determines if the child responds to scientific, research-based intervention as a part of evaluation procedures (20 U.S.C. § 1414(b)(6); 34 C.F.R. § 300.307(a)). Many states have begun to adopt Response to Intervention (RtI), an education approach which provides an empirical demonstration that a student is in need of specially designed instruction because he or she has failed to respond successfully to instruction ordinarily delivered to typical students. In an RtI model, a student's lack of progress when compared to peers, national norms, or curriculum expectations signals the need for intensification of efforts within general education. Early and frequent measurement of progress alerts school personnel to intensify and carefully target instruction where progress is lacking. Continued failure to respond in spite of increased efforts should then result in a referral for special education services.

[2] The reports of both the House and Senate Committees accompanying the IDEA reauthorization bills reflect the Committees' concerns with models of identification of SLD that use IQ tests, and their recognition that a growing body of scientific research supports methods, such as RTI, that more accurately distinguish between children who truly have SLD from those whose learning difficulties could be resolved with more specific, scientifically based, general education interventions. Similarly, the President's Commission on Excellence in Special Education recommended that the identification process for SLD incorporate an RTI approach. (see U.S. Department of Education: Building the Legacy of IDEA – Questions and Answers on RTI and EIS.

While a discrepancy model signaled attempts to remedy reading challenges through specially designed instruction after establishing eligibility, RtI seeks to prevent or limit the manifestation of a reading disorder through highly focused, scientifically based instruction prior to the buildup of an IQ/achievement discrepancy. Neither model can ignore the important connection to curriculum access and the need for a compensatory or supportive approach through the provision of AEM.

II. Provision of AEM to Support Reading Challenges of Students with Learning Disabilities

Overview of Legal Requirements Pertaining to AEM

Until the late 1990s, the focus of IDEA was to provide specially designed instruction in least restrictive, yet appropriate, settings. In such settings, curriculum was targeted at reducing or eliminating the challenges arising from disability. Frequently, the curriculum for students with disabilities was viewed as entirely separate from that which was provided to students without disabilities (Hitchcock, Meyer, Rose, & Jackson, 2002). As part of the 1997 re-authorization of IDEA, however, explicit provisions were added to IDEA regarding the need to ensure that students with disabilities have access to (20 U.S.C. § 1400(c)(5)(A); 34 C.F.R. § 300.26(b)(3)), are involved in, and make progress in the general education curriculum (currently at 20 U.S.C. §§ 1414(d)(1)(A)(i)(I), (II), (IV); 34 C.F.R. §§ 300.320(a)(1), (2), (4))—i.e., the same curriculum as that provided to students without disabilities (34 C.F.R. § 300.320(a)(1)(i]).

Recognizing the crucial role that educational materials play in helping students learn the knowledge and skills that are embedded in the general education curriculum, as part of the 2004 re-authorization of IDEA. Congress included a number of provisions designed to improve the quality and delivery of educational materials in accessible formats. In particular, IDEA 2004 established the National Instructional Materials Accessibility Standard (NIMAS), a technical standard to be used in the conversion of print instructional materials into accessible formats (i.e., braille, audio, digital text, or large print) (20 U.S.C. §§ 1474(e)(3)(B), 1474(e)(3)(D)), and the National Instructional Materials Access Center (NIMAC), a national repository for NIMAS source files (20 U.S.C. § 1474(e)(2)).

In order to be able to receive materials developed from NIMAS source files through the NIMAC, students must be served under IDEA and qualify in accordance with “An Act to provide books for the adult blind” (20 U.S.C. § 1474(e)(3)(A) (citing 2 U.S.C. § 135a)).

To qualify under the latter, students must fall into one of four eligibility categories specified in regulations issued by the Library of Congress (LOC) as part of the National Library Service for the Blind and Physically Handicapped—namely, (1) blind persons, (2) persons with visual disability, (3) persons who are unable to read or unable to use standard printed material as a result of physical limitations, and (4) persons who have a reading disability resulting from organic dysfunction and of sufficient severity to prevent their reading printed material in a normal manner (36 C.F.R. § 701.6(b)(1)).

Each category must be certified by a "competent authority" as meeting the eligibility criteria (36 C.F.R. § 701.6(b)). For the first three categories (persons who are blind, have a visual disability, and/or have physical limitations), the regulations define "competent authority" as including "doctors of medicine, doctors of osteopathy, ophthalmologists, optometrists, registered nurses, therapists, and professional staff of hospitals, institutions, and public or welfare agencies (e.g., social workers, case workers, counselors, rehabilitation teachers, and superintendents)" (36 C.F.R. § 701.6(b)(2)(i)). For these three categories, the regulations also state the following: "In the absence of any of these [individuals qualified to serve as a competent authority], certification may be made by professional librarians or by any person whose competence under specific circumstances is acceptable to the Library of Congress" (36 C.F.R. § 701.6(b)(2)(i)). In contrast, for the fourth category, "reading disability resulting from organic dysfunction," a "competent authority" is defined as "doctors of medicine who may consult with colleagues in associated disciplines" (36 C.F.R. § 701.6(b)(2)(ii)).

Thus, a student with a learning disability who is certified by a doctor of medicine as having a reading disability resulting from organic dysfunction and of sufficient severity to prevent the reading of printed material in a normal manner would fall under the fourth eligibility category and would be able to receive accessible educational materials derived from NIMAS files obtained through the NIMAC.[3] Both Learning Ally and Bookshare, two major accessible media producers (AMPs), interpret the LOC regulations to mean that because of the physiological basis of learning disabilities, students with learning disabilities may be certified by any competent authority that is permitted under the category of "physical limitations," including special education teachers or school psychologists.

Regardless of whether a student with a learning disability falls under one of the LOC categories, if a student's Individualized Education Program (IEP) team determines that

[3] For a more thorough discussion of the legal requirements concerning the provision of AIM to students with learning disabilities, see Karger (2010, 2012).

the student needs Accessible Instructional Materials (AIM) (20 U.S.C. §1412(a)(23)) in order to receive a free appropriate public education (FAPE), that student must be provided these materials in a timely manner. IDEA regulations state explicitly that nothing relieves a state educational agency (SEA) or local education agency (LEA) of its responsibility to ensure that children with disabilities who need instructional materials in accessible formats but are not included under the definition of blind or other persons with print disabilities or who need materials that cannot be produced from NIMAS files receive those materials in a timely manner (34 C.F.R. §§ 300.172(b)(3), 300.210(a)(3)). For students who are unable to receive accessible materials through the NIMAC, SEAs and LEAs must obtain these materials in other ways. The U.S. Department of Education has stated that timely access to appropriate and accessible instructional materials is an inherent component of the obligation of public agencies to ensure that FAPE is available for children with disabilities and that children with disabilities participate in the general education curriculum as specified in their IEPs (71 Fed. Reg. 46540, 46618 [Aug. 14, 2006]).

In accordance with 34 CFR 75.105(b)(2)(v), in 2014 the National Center on Accessible Educational Materials for Learning priority was funded from allowable activities specified in the statute (see sections 674 and 681(d) of the Individuals with Disabilities Education Act (IDEA) (20 U.S.C. 1400 et seq.)). The Center's efforts will help support equitable opportunities for children with disabilities to: (1) participate in high-quality early learning programs, (2) be involved in and progress in the general education curriculum, (3) prepare to meet college and career-ready standards, (4) participate in assessments, and (5) transition to postsecondary education and the workforce. Given the ubiquitous use and transformative impact of technology on learning, the scope of activities of the Center was expanded to ensure both print- and technology-based educational and core materials are accessible to and used by all children with disabilities. SEAs and LEAs obligations related to AIM as required under IDEA continue.

Potential Benefits of AEM for Students with Specific Reading-Related Learning Disabilities

Traditionally, interventions that focused on remediation or correction limited access to the general education curriculum because the academic skills required for curriculum access were considered deficient and consequently had to be corrected before a student was deemed able to join the general track. Today with the advent of digital media and technology tools, however, curriculum access may go forward while academic skills deficits are being remediated. Thus, for students with learning disabilities who present with specific reading challenges, supports can be put in place

that facilitate or compensate for many of the learning challenges resulting from their disability (Boyle, et al., 2003; Higgins & Raskind, 1997).

Accessible versions of instructional materials that have been developed through the NIMAC or via other sources can be helpful for students whose word deciphering abilities or reading rates have previously prevented them from participating in routine classroom instruction. Since the vast majority of students diagnosed with specific learning disabilities struggle with reading as a result of their disability (Fletcher, et al., 2007), it is no surprise that a number of these students rely on services originally intended for use by individuals who are blind or who have low vision. The National Library Service's Talking Book Program and Learning Ally are notable examples of providers of such services. These services make available voice-recorded versions of books and periodicals.

For students whose difficulty rests with decoding or rapid naming of words, it is reasonable to assume that listening to pre-recorded or synthesized (computer-generated) speech can serve several vital functions. For example, pairing written text with speech helps to sustain engagement during the reading task. Listening while viewing text can connect students directly to the text itself while the meaning of the text can be captured through listening. Additionally, listening to text presented synchronously with speech may possibly serve a remedial function, particularly with regard to building speed or fluency. Moreover, early use of voice recorded text may limit the ever-widening gap in learning that is all too often observed in elementary grades with struggling readers (Cunningham & Chen, 2014; Stanovich, 1986). Typical learners who receive high-quality literacy instruction develop rapidly in their acquisition of reading skills. Their general knowledge and vocabulary expand as they read about life in general and the world beyond their direct experience. Without audio recordings of printed text, these students would be denied the opportunity to learn about and to discuss what their peers are benefiting from through text reading. Thus, for many who struggle with text reading, listening to text affords an opportunity to access and participate in the general education curriculum—i.e., the same curriculum offered to students without disabilities.

As a caveat, it is important to note that listening to audio recordings of printed text will not substitute for explicit, carefully targeted instruction in literacy skills for students who struggle early. However, providing the opportunity to listen to text while learning to read can prevent students from disengaging with or turning away from text altogether. Nevertheless, reading with audio supports must be recognized as an ancillary aid crucial for learning, especially where struggling readers are able to access the same content as their peers.

III. ASR and Students with Learning Disabilities

Overview of ASR

The concept of ASR was first elucidated in a paper written for the AIM Center (Jackson, 2012). Focusing on students who are blind or who have low vision, the paper defined ASR as a technique for reading in which users access a digital text format for displaying magnified print or refreshable braille along with TTS screen reader technology. The paper noted that students who are blind or have low vision have always been challenged by limited access to reading materials customarily available to the general population. Today, digitization of printed materials in accessible formats has greatly reduced this access problem, but the efficient use of accessible materials for purposes of learning remains a central challenge. Further complicating this challenge is the fact that print and braille reading rates for blind and low vision learners compare unfavorably to those of typically-seeing classmates (Ferrell, Mason, Young, & Cooney, 2006). These comparatively depressed reading rates are an unfortunate yet seemingly unavoidable consequence of the limitations of the tactile and impaired visual systems (MacDonald, et al., 2012).

A distinct advantage of audio-supported reading in addressing reading rate issues is that ASR allows the user to bypass the sensory and motor skills typically required for reading connected text by allowing an individual to listen to text read aloud at substantially faster rates. Today technologies are in use that far exceed the capabilities of the “talking book machines” and audio tape players of yesteryear. Application of these technologies makes possible an entirely new approach to reading and working with text. Using screen magnification or refreshable (paperless) braille simultaneously or in combination with speech gives the reader the potential to cover text at rates comparable to those of typically-sighted readers. The use of TTS technology to accompany either refreshable braille or screen-magnified print serves as a support for making reading in the student’s primary modality (print or braille) more efficient. In ASR, speech is not a substitute for braille or print reading but rather an enhancement of those media that makes the entire reading process more efficient for purposes of processing material in a timely fashion with good comprehension.

In the field of educating blind and visually impaired children, learning to read either braille or magnified print and learning to listen to spoken text have been approached as separate domains of learning within specialized curriculum for teaching students who are blind or visually impaired. First, of paramount importance to the young child is to establish a primary learning medium in either print or braille through a process known as the Learning Media Assessment or LMA. Then, learning to listen to text is introduced

at a later time in the child's literacy development, largely for the purpose of compensating for the relative paucity of reading materials available in either braille or large print. One notable exception to the separation of text reading from listening was proposed by Evens (1997) using an approach she called audio-assisted reading. In this approach, students who struggle with reading braille use tape recorded material to follow along while reading hardcopy braille. Evans' proposed audio-assisted reading was intended explicitly for the purpose of building braille reading speed. The goal was to remove the listening component once speed of hand tracking and braille character recognition were hastened. Evans was particularly concerned with students whose braille reading skills were lagging behind those of their braille reading peers. Thus, she proposed to examine the potential effects that audio-assisted reading might have on correcting deficits in braille reading fluency. Audio-assisted reading had great intuitive appeal since it mimicked so well the widely applied practice of the read-aloud where a teacher serves as a model of proficient oral reading for students to follow along with for the purpose of improving reading speed (Chard, Vaughn, & Tyler, 2002).

Limited Literature Pertaining to ASR and Students with Learning Disabilities

Since Evans first proposed audio-assisted reading as a technique for building speed among struggling braille readers, several studies have investigated the utility of this approach with struggling readers who were not visually impaired, including those with learning disabilities. At this time, the remedial benefits of audio-assisted reading or TTS for students with learning disabilities are not well established or understood. Some studies have found an association between TTS and improvements in reading rate (Elkind, 1998), reading comprehension (Elkind, Cohen, & Murray, 1993; Higgins & Raskind, 2005, 1997; Roberts, Takakashi, & Stodden, 2012); reading fluency (Roberts, Takakashi, & Stodden, 2012); and reading endurance (Elkind, 1998; Elkind, Black, & Murray, 1996). Improvements in math performance have similarly been demonstrated for some students with learning disabilities who use TTS for math problems (Helwig, Rozek-Tedesco, Tindal, Heath, & Almond, 1999; Tindal, Heath, Hollenbeck, Almond, & Harniss, 1998).

At the same time, however, a number of studies have shown mixed results for efficacy with respect to audio-assisted reading or TTS and students with learning disabilities (see, e.g., Elbaum, Arguelles, Campbell, & Saleh, 2004; Esteves, 2007; Lesnick, 2006; Meloy, Deville, & Frisbie, 2002). Studies such as these that employ large sample sizes in which the precise nature of participants' reading disorder is not clearly defined may show mixed results because the participating students may struggle for very different reasons, some of which may involve language processing difficulties that are

independent of input modality. As a consequence, these individuals may not be able to exploit the auditory channel for building speed or improving comprehension (Nation, 2005). For students who struggle primarily as a result of word-level difficulties (decoding or rapid word naming), the supportive or facilitative nature of listening while reading is clear.

It is with this group of readers who struggle at the word level that recent development in ASR for learners who are blind or who have low vision are primarily applicable. Increased support for or facilitation of the reading process through speech concurrent with printed text can increase opportunity to learn by providing direct access to the curriculum ordinarily delivered through visual reading. Without ruling out possible remedial benefits of ASR for students with learning disabilities, the claim made here is that students who struggle with decoding and word recognition while trying to engage with print alone may be better able to apply their cognitive capacity for language processing and comprehension while listening to text read aloud in sync with screen-presented text.

IV. Key Considerations for Future Work in This Area

More work is needed in the area of ASR and students with learning disabilities. Building on the prior discussion of the application of ASR to the reading experiences of students who are blind or who have low vision, the following discussion presents three key considerations to help guide future work concerning the use of the ASR technique by students with learning disabilities:

Not All Students with Learning Disabilities Are Likely to Benefit Equally from ASR

Unlike visual impairment, hearing impairment, or orthopedic impairment, the presence of a learning disability has many manifestations. For example, an unusual or unexpected difficulty with learning can be limited to decoding text or to the solving of mathematical problems. A pronounced difficulty with learning could also be attributed to distractibility, impulsivity, problems with metacognition, self-regulation, or motor planning. Thus, in contrast to challenges resulting from impaired vision or hearing, learning disabilities are best described as a complex and heterogeneous group of conditions, each one of which can substantially interfere with learning. Given this heterogeneity, it is likely that not all students with learning disabilities will benefit from ASR in equal ways.

While the compensatory benefits of listening to text are experienced by many with reading challenges, not all individuals comprehend text any better when text is read aloud. The mechanisms through which children acquire and use language are complex and multi-dimensional. Difficulties with processing one's own native language can certainly limit or impair reading comprehension whether text is delivered directly or mediated by listening (Nation, Clarke, Marshall, & Durand, 2004). For example, there are individuals who read text out loud with adequate fluency but do not comprehend proficiently (Schwanenflugel, et al., 2006). Comprehension, either through reading text or listening to text, may be similarly problematic. Thus the process of deriving meaning from text, however presented, may be impaired at the language processing level. On the other hand, individuals with reading challenges that are manifested at the word level through difficulties with decoding or rapid naming of words may be among the most likely candidates to profit from listening to printed text read aloud. Here, the same compensatory benefits derived by individuals who are blind or visually impaired can be experienced. For students with specific learning disabilities who struggle at the word level, it is likely that using ASR with existing technology can result in benefits similar to those enjoyed by individuals who are blind or visually impaired.

New Technology Allows Students with Learning Disabilities to Exert Choice and Control over Their Reading Experience

One of the key attributes of ASR is its capability to bring the reading process under the executive control of the user. In earlier approaches to reading through listening (referred to above), the reader remained relatively passive. To explain this point further it is important to note that proficient print readers typically execute a broad range of control strategies to adjust the rate at which they move through text, but those who only listen to text are perceived as merely sitting back and "letting it happen" at a fixed listening rate. This perception is based on the notion that audio input is run as a steady string of utterances from a dispassionate robotic voice. Quite to the contrary, current speech technology can change rate on the fly, stop, start, review, and jump forward under the control of the user. Today, speech technologies also have selectable high-quality voices. The interactivity afforded by these technologies approximates the control typical readers impose on a reading task which is key to effective strategic reading. Such control enables the reader to stop and think, re-read, jump ahead, and slow down for close reading. ASR supports the use of such strategies that in turn enable use of metacognition or "thinking about thinking" for deriving meaning from text which, again, is the ultimate goal for reading. Finally, ASR's capacity to allow a reader to control the rate

at which text is presented helps to facilitate sustained engagement and freedom from distraction.

Students with Learning Disabilities Might Not Use Each Modality Equally All of the Time

To any reading task, readers bring an organized conceptualization of their background knowledge. What do I know (declarative knowledge)? How do I do things (procedural knowledge)? Referred to as *schema*, this knowledge base resides in long-term memory (LTM) with relative permanence, according to information processing theory. For any given passage of text, a variable combination of both new (novel) information and familiar (previously stored) content is displayed for the user on screen and by voice.

In discussing ASR in relation to students who are blind or have low vision, Jackson (2012) explained that ASR does not require the reader to use digital text/braille and TTS equally 100% of the time. Rather, the user can decide when to use each of the two modalities in a strategic manner. Similarly, students with learning disabilities who experience challenges with decoding or rapid naming at the word level can elect to listen primarily and use vision to monitor the input when text is highly familiar. On a different task, when text is difficult and demands close attention, the user with word-level reading challenges can elect to pause, reflect, and question the text using whatever resources are available to working memory. Thus, the combination of inputs from screen and voice need not result in cognitive overload since the proportion of modalities (vision and hearing) is selected by the user whose active working memory is monitoring comprehension during the reading task.

Conclusion

Given the increasingly widespread availability of digital text and technology tools today, efforts to prevent or remediate specific reading difficulties of students with learning disabilities, which have not yet succeeded, need not result in a failure to learn. ASR has the potential to benefit students with specific reading-related learning disabilities, in particular those who experience challenges with respect to word-level reading. This paper has presented an introduction to the concept of ASR for students with learning disabilities. It has been argued that a nuanced perspective on this topic is appropriate, with consideration given to such issues as which students with reading-based learning disabilities are most likely to benefit from ASR, how new technology can support students with learning disabilities in their metacognition and sustained engagement, and

how students with learning disabilities can be supported to develop the appropriate strategies to utilize each modality in a purposeful and effective manner.

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