☑ CE Article

Audible Image Description as an Accommodation in Statewide Assessments for Students with Visual and Print Disabilities

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Structured abstract: *Introduction:* Although image description has been identified as an accommodation for presentations conducted in the classroom, only a few U.S. states have approved it for use in high-stakes assessments. This study examined the use of audible image description as an assessment accommodation for students with visual and print disabilities by investigating student comprehension under multiple conditions. *Methods:* Students in three western states in grades three through eight who had visual (n = 117) or print (n = 178) disabilities participated in an abbreviated test constructed of retired assessment questions in English language arts, mathematics, and science, that were aligned with each state's instructional standards, under conditions with and without standardized description of graphic images. The study used a within-subjects block design to collect and compare comprehension data under conditions where audible image description was both used and not used in an abbreviated test. *Results:* Results indicated that students who read braille were more likely to respond correctly under the audible image description condition, and students with visual and print disabilities who used print were equally likely to respond correctly regardless of condition. *Discussion:* Braille readers were more likely to obtain a correct answer when audible image description accompanied the question. Audible image description did not affect the likelihood of a correct response from students with print disabilities or students with visual disabilities who read print. *Implications for practitioners:* Audible image description is an accommodation that may help braille readers perform better on tests. Although the Partnership for Assessment of Readiness for College and Careers (PARCC) and Smarter Balanced consortia are taking steps to include image (or picture) descriptions in their assessment accommodations, teachers may want to develop a standard

method for describing images and familiarize their braille readers to the strategy by including it in instruction and in classroom tests. Readers are referred to the National Center on Accessible Media's online guidelines for image description.

Image description, a method of providing access to complex images and graphics to children with visual and print disabilities, is increasingly important in today's multimedia classrooms. The amount of material with elements needing description is so pervasive—videos, DVDs, CDs, web pages, textbooks, as well as aspects of leisure and recreational activities—that the U.S. Department of Education has taken an active role in stimulating research and practice to make such images and graphics accessible to individuals with visual and print disabilities. Some of the projects that have been supported include: a cooperative agreement with the National Association of the Deaf to create the Described and Captioned Media Program (DCMP); the Video Description Research and Development Center at Smith-Kettlewell Eye Research Institute; and the Digital Image and Graphic Resources for Accessible Materials Center (DIAGRAM Center), part of Beneficent Technology (Benetech). There are a number of additional research studies and projects designed to provide real-time remote audio description, or description by crowdsourcing, but there has not been any research examining audible image description as an accommodation in assessment (Abedi & Ewers, 2013).

Although image description has been identified as an accommodation for presentations given in the classroom (Thompson, Morse, Sharpe, & Hall, 2005), such description has only been approved by a few U.S. states for use in high-stakes assessments (Christensen, Lazarus, Crone, & Thurlow, 2008). The Smarter Balanced Assessment Consortium and the Partnership for Assessment of Readiness for College and Careers (PARCC) permit image description when it is included as an accommodation on a student's Individualized Education Program (IEP) or 504 plan (Measured Progress/ETS Collaborative, 2012; PARCC, 2014a, 2014b). The PARCC and Smarter Balanced consortia largely leave picture description up to test administrators, who can decide whether the image is essential to the question and whether description is required or not, although it should be noted that PARCC provides alternative or "alt" text and paragraphs that describe some of its images. Audible image description has the potential to control standardized test administration, since all students would receive the same image description (rather than leaving it to individual human readers to describe the graphics in their own words); increase independent access to graphic content

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(because students could control the speed of the description); and reduce costs in test construction (by creating a recording rather than a tactile graphic). Previous research on use of audio description by students with visual impairments has suggested that such description can increase comprehension of video materials when it is provided for relevant content (Ely et al., 2006).

The Utah State Office of Education (USOE) received an Enhanced Assessment grant from the Office of Elementary and Secondary Education in 2010. Working in partnership with representatives from the Colorado Department of Education (CDE), the Kansas State Department of Education (KSDE), the National Center for Accessible Media at WGBH (NCAM), and the National Center on Severe and Sensory Disabilities (NCSSD) at the University of Northern Colorado, the grant-funded project examined the use of audible image description as an assessment accommodation for students with visual and print disabilities by investigating student comprehension under multiple conditions. A secondary goal was to document meaningful and effective practices for access to visual and complex images within high-stakes assessments. A key feature of this project was the application of audible image description practices for students with print disabilities other than visual impairment, who are defined by Thompson et al. (2005) as those students who have a "difficulty or inability to visually read standard print because of a physical, sensory, or cognitive disability" (p. 25).

The use of description has greatly expanded due to the passage of the 21st Century Communications and Video Accessibility Act in 2010. The law not only requires broadcasters to provide description in their television programming, but it requires that digital content provided over the Internet must also be accessible to individuals with disabilities. In today's typical classroom, digital content offered through the Internet is ubiquitous. According to Thompson et al. (2005), "the accommodations provided to a student must be the same for classroom instruction, classroom assessments, and district and state assessments" (p. 14). Since there seems to be some reluctance by states to permit audible image description in testing situations, in spite of Thompson et al.'s axiom, this project sought to determine if audible image description provided advantages or disadvantages for students with visual and print disabilities. Given the adoption of computer-based assessment with the advent of PARCC and the Smarter Balanced consortia, determining whether audible image description of graphic images is an unbiased accommodation seems important for all students with disabilities.

This study thus investigated the following question: Does audible image description affect the comprehension of students with visual or print disabilities when responding to questions in English language arts (ELA), mathematics, or science?

Methods

The study used a within-subjects block design (illustrated in Table 1) to collect and compare comprehension data under conditions in which audible image description was both used and not used in a limited test of retired test items with students who had visual or print disabilities. Print readers received two questions each in ELA, mathematics, and science, under two conditions, with and without audible image description. Braille readers,

Table 1
Randomized block design for reading mode and experimental conditions.

	Presentation conditions for each content area (ELA, mathematics, science)		
Reader type	Reading mode	Description	Tactile graphics
Braille readers	Braille (9 questions)	Yes	Yes
		No	Yes
		Yes	No
Print readers	Print (6 questions) (large print, standard print, standard print with magnification)	Yes	—
		No	

however, were tested under three conditions: with tactile graphics, the standard accommodation; with audible description of the graphic image; and with both a tactile graphic and audible description of the graphic image. The order of conditions and content of questions was randomly assigned electronically at the time of testing, so that each participant received questions in each content area under each condition. Cooney, Young, Luckner, and Ferrell (2015) recommend the within-subjects design, where participants receive all conditions, as a method for establishing causal validity because the participants act as their own control group. In this study, participants were randomly assigned first to each study condition, and then to one of nine or six questions, depending on whether they were braille or print readers. Thus, there were no order effects, since each participant was tested in a different sequence of conditions, content areas, and questions.

Study participants

Recruitment

Student participants were identified through their teachers, who were asked to recommend students in grades three through eight who had visual or print disabilities and who had taken or were eligible for the state's standard large-scale statewide assessment. Teachers were solicited through announcements that were distributed to local education agency special education directors, assessment directors, curriculum directors, special education teachers, and parents or guardians of children with disabilities in the three states. Project announcements, which described the project and offered an honorarium, were also distributed to newsletters and electronic discussion groups for teachers of students with visual or print disabilities. The project announcement was also shared with teachers at training sessions, meetings, and conferences.

After making initial contact with the project coordinators, teachers were asked to return a consent form and to distribute consent forms to the parents or guardians of students who met the requirements for the study, according to Institutional Review Board (IRB) procedures at the University of Northern Colorado. Once both teacher and parent or guardian consent forms were received, test administrators scheduled visits with the teacher and students.

Students

A total of 295 student participants were tested: 178 with print disabilities and 117 with visual disabilities. Of the students with

Table 2
Number and percentage of student participants, by grade level and state.

Grade	Colorado *n* (%)	Kansas *n* (%)	Utah *n* (%)	Total *N* (%)
3	20 (21.05)	3 (9.09)	34 (20.36)	57 (19.32)
4	23 (24.21)	13 (39.39)	33 (19.76)	69 (23.39)
5	16 (16.84)	5 (15.15)	30 (17.96)	51 (17.29)
6	19 (20.00)	4 (12.12)	26 (6.06)	49 (16.61)
7	7 (7.37)	2 (6.06)	26 (15.57)	35 (11.86)
8	10 (10.53)	6 (18.18)	18 (10.80)	34 (11.53)
Total	95 (32.03)	33 (11.19)	167 (56.61)	295 (100.00)

visual disabilities, 28 were braille readers, 73 used large print, and 16 used standard print. The number of student participants by grade level and state is indicated in Table 2. The majority of students came from Utah ($n = 167$) and the greatest grade-level participation was fourth grade ($n = 69$). Although every attempt was made to secure equal numbers of students in each grade from each state, we were unsuccessful. This situation necessitated the use of a specific statistical procedure described below. Student participants were identified by their teachers as having either a print or a visual disability at the time of testing. The majority of Colorado students (62.11%) had visual disabilities; in Kansas and Utah, the majority of students had print disabilities (60.61% and 73.05%, respectively). Slightly less than 5% of all students with print disabilities chose large print as their reading medium, and almost 14% of students with visual disabilities selected standard print as their reading medium.

Students with visual disabilities. Teachers of students with visual disabilities reported an array of visual diagnoses for their students. The most common diagnoses were optic nerve hypoplasia (13.7%) and some form of albinism (12.8%).

Students with print disabilities. "Print disability," although it is referred to in the Individuals with Disabilities Education Act (2004) in relation to the National Instructional Materials Accessibility Standard (NIMAS), Individuals with Disabilities Education Act (IDEA), §§ 612(a)(23)(B), 613(a)(6)(B), is defined by the Code of Federal Regulations (1981) for the National Library Service for the Blind and Physically Handicapped (NLS) as:

> (iii) Persons certified by competent authority as unable to read or unable to use standard printed material as a result of physical limitations.
> (iv) Persons certified by competent authority as having 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. 701.10(b)).

In this study, the students who were identified by their teachers as having a print disability were overwhelmingly reported as having learning disabilities (79.3%). Other disabilities reported included autism, speech or language disorders, and a variety of physical disabilities such as muscular dystrophy and other health impairments.

Test development

An essential component of this project was the development of an assessment that could be used to evaluate the effectiveness of audible image description as an accommodation. The process to design the assessment included the development of a test item bank, bias and sensitivity review, and production of the assessment in multiple formats (print, large print, braille with tactile graphics, and audible image description).

The test item bank for this assessment was developed using items selected from the Utah Test Item Pool Server (UTIPS). UTIPS is an online formative assessment tool with non-secure test items. The items were developed by active Utah educators in cooperation with the Utah State Office of Education. Items are aligned to the Utah Core Curriculum (now Utah Core Standards) by standard and indicator, and where appropriate by intended learning outcome. The item pool consisted of multiple item types (such as forced response, essay, matching, short answer, grouped questions, and performance questions); we selected only forced response items so that no interpretation of students' answers was required.

The resulting test item bank for this project consisted of 340 total items (101 ELA, 143 mathematics, 96 science). Two reviewers evaluated each question for face validity, based on how well an individual test item measured an identified standard. For ELA and mathematics test items, the standards were matched to the Common Core State Standards (National Governors Association, 2010) adopted by the three states. Since the Common Core State Standards did not include standards for science at the time of the study, each science question selected corresponded to a grade level standard shared by Utah, Kansas, and Colorado.

Three test questions were selected for each subject area and grade level, yielding 54 items. These were then sent to the Colorado Visual Bias Committee for review. This committee was charged by the Colorado Department of Education with reviewing statewide test items for questions that assumed visual knowledge and were thus considered biased against students with visual impairments. Some of the 54 items were edited or deleted because the question was outside of the direct experience of students with visual impairments, and backup questions were substituted. Items were then sent to NCAM for the design and scripting of the descriptions for the graphic part of each test item. Again, some items were rejected and replaced based on tactile or description production needs. Audible image descriptions were scripted and recorded by NCAM staff members and distributed to project staff members for verification and review. Final items selected for each grade level and subject area were sent to the Utah State Instructional Materials Access Center (USIMAC) for final production in print, braille, braille with tactile graphics, and large print. NCSSD staff members conducted a proofreading and editing review of the assessment in all formats and requested revisions that made the questions consistent in terms of formatting and braille code usage. Each test question included accompanying digital files with the audible image description in human voice.

Test administration

Three researchers and three graduate research assistants were trained as test administrators. The training consisted of reviewing the testing procedures according to a script developed by project staff members, practicing with the electronic data collection tool, and pulling the randomized question in the correct medium and condition. Test administrators set up appointments with teacher participants once consent forms were received from both teachers and parents or guardians, and then traveled throughout each state to test student participants.

The test was administered with the teacher present, although not always in close proximity. After preliminary introductions, the test administrator asked student participants for their assent to participate in the study, using a script approved by the University of Northern Colorado's IRB; when students assented, they signed a form containing the assent script and witnessed by test administrators. Teacher participants completed a student information form while the test was being administered. The student information form requested the student's disability diagnosis and the type of accommodations identified for each student, as well as asking the teacher's opinion of each student's current reading status (on grade level or not).

Randomization and sequence of administration

Simultaneously with the test development phase, an external consultant created a website for the collection of data using iPads. The website collected demographic data about the student being tested (birthdate, gender, state, grade, print or visual disability, and reading modality), then generated a unique identifier that was used for all subsequent data collection for that student. The website then presented questions randomly within each medium (print, large print, braille) by content area (ELA, science, mathematics), question number, and condition (audible image description, tactile graphics, tactile graphics plus audible image description). The number of questions and the conditions for testing were determined by the responses to disability (print or visual) and reading modality (standard print, large print, and braille). Student participants received each question only once, but the condition and sequence varied across students. The test administrator played the audible image description only when instructed to do so by the on-screen program. Student participants' responses were recorded for one question before proceeding to the next randomized question. Test administrators did not know the order of questions and conditions until directed by the on-screen program. This random assignment procedure was established to control for any order effects that might have occurred.

Practice items

Because participants, including those with visual impairments, had different degrees of exposure to audible image description, the research team selected six practice questions accompanied by description of the graphics in each to administer to participants before the test protocol was administered. The number of practice questions was reduced to three soon after testing began, because students were acclimated to the audible image description procedure quickly.

Data analysis

The GENMOD procedure in SAS 9.3 was used to fit a generalized linear model to the categorical repeated measures design (multiple administrations of the same question

Table 3
Proportion of correct responses by content area and reading medium.

Content area	Reading medium: Standard print	Large print	Braille	Total
ELA	53.42	62.50	52.38	56.10
Science	55.48	50.00	46.43	50.64
Mathematics	52.05	56.25	40.48	49.59
Total	53.65	56.25	46.43	52.11

Table 4
Proportion of correct responses by content area and disability category.

Content area	Print disability	Visual disability, reads print	Visual disability, reads braille
ELA	54.78	55.06	52.38
Science	43.82	55.49	46.43
Mathematics	45.48	52.81	40.48
Total	48.03	54.20	46.43

under different conditions). After consulting with a statistician, this procedure was determined to best fit the data, because it treated each response to each question in each condition as a discrete observation and would model the average response pattern. Students' results were analyzed by disability and medium, collapsing large print and standard print into the visual disabilities group (and using large print as a variable). The results indicated the likelihood of students attaining a correct response under each condition, content area, and reading medium. We followed the recommendation of Chinn (2000), using the parameter estimate or odds ratio calculated by the GENMOD procedure to determine effect size.

Results

A total of 1,852 questions were administered to the 295 participants. Participants responded correctly to 52.11% of those questions (see Table 3). There were differences in responses by content area, reading medium, and disability group. ELA questions were answered correctly 56.10% of the time, and 50.64% of science and 49.59% of mathematics questions were answered correctly. Large print readers had the highest proportion of correct responses (56.25%) across all content areas, followed by standard print readers (53.65%) and braille readers (46.43%), who had the lowest proportion of correct responses. As explained earlier, some students with print disabilities read large print, and some students with visual disabilities read standard print, so a separate analysis of responses was computed by disability group. In this analysis (see Table 4), students with print disabilities responded correctly to 48.03% of the questions. Students with visual disabilities who read print had the greatest proportion of correct responses (54.20%), and braille readers responded correctly to 46.43% of the questions. In general, ELA questions were answered correctly more often than science or mathematics questions, and students with low vision who used print answered a greater proportion of questions correctly.

Students with print disabilities

For participating students with print disabilities, a total of 1,066 observations contributed to the analysis. For 512 of these observations, the student response was correct, and for 554 observations, the student response was incorrect. The mathematics questions were selected as the baseline (intercept), and the parameters of the analysis measured the relative effect on the likelihood of a correct answer due to the grade level, content area (science or ELA), use

Table 5
Analysis of Generalized Estimating Equation (GEE) parameter estimates for students with print disabilities.

Empirical standard error estimates							
Parameter	Estimate	Standard error	95% confidence limits		Z	$Pr > [Z]$	Effect size
Intercept (mathematics)	0.1945	0.2502	−0.2958	0.06849	0.78	0.4368	0.1072
Grade	−0.0586	0.0407	−0.1384	0.0212	−1.44	0.1503	−0.0323
Large print (LP)	−0.7487	0.5881	−1.9014	−0.4039	−1.27	0.2030	−0.4128
Description	−0.1096	0.2069	−0.5152	0.2959	−0.53	0.5963	−0.0604
ELA correct	0.3172	0.2221	−0.1181	0.7525	1.43	0.1532	0.1748
Science correct	−0.1560	0.2183	−0.5839	0.2719	−0.71	0.4748	−0.0860
LP * description	−0.0154	0.5341	−1.0621	1.0314	−0.03	0.9771	−0.0085
LP * ELA	0.3919	0.7082	−0.9961	1.7800	0.55	0.5800	0.2161
LP * science	0.8538	1.0737	−1.2508	2.9583	0.80	0.4265	0.4707
Description * ELA	0.0875	0.3120	−0.5240	0.6990	0.28	0.7791	0.0482
Description * science	0.1103	0.2908	−0.4596	0.6802	0.38	0.7044	0.0608

Effect sizes were calculated on the odds ratio (parameter estimate) using the formula suggested by Chinn (2000).

of large print, condition (description or no-description), and interactions among these variables. The results of the GENMOD procedure are presented in Table 5. In Table 5, the Estimate column refers to the likelihood of each parameter, or variable, in producing a correct answer. For the intercept-baseline (the mathematics questions), students with print disabilities were .19 times more likely to respond correctly. The probability (column $PR > [Z]$) was not significant, and the effect size was small, at .1072. None of the Z-scores for students with print disabilities were significant, indicating that the audible image description condition for students with print disabilities had no effect on the likelihood of responding correctly.

Students with visual disabilities

Two analyses were conducted for participating students with visual disabilities: one for those using print (regular and large print), and one for those using braille. For students with visual disabilities who read print, there were a total of 534 observations that contributed to the analysis. For 289 of these observations, the student response was correct, and for 245 observations the student response was incorrect. The mathematics questions were again selected as the baseline (intercept), and the parameters of the analysis consisted of responses to the science and ELA questions; use of large print; presence of audible image description; grade level; and interactions among these variables. The results are presented in Table 6. The results indicated that children with visual disabilities reading either regular or large print were .6437 times less likely to provide a correct response in the description condition (non-significant; $E.S. = -.35$). None of the Z-scores for students with visual disabilities who read print were significant, indicating that the audible image description condition for students with visual disabilities who used print had no effect on the likelihood of responding correctly.

Table 6
Analysis of GEE parameter estimates for students with visual disabilities who read print.

Parameter	Estimate	Standard error	95% confidence limits		Z	Pr > [Z]	Effect size
	Empirical standard error estimates						
Intercept (mathematics)	0.6690	0.5355	−0.3805	1.7186	1.25	0.2115	0.3688
Grade	−0.0201	0.0581	−0.1340	0.0937	−0.35	0.7288	−0.0111
Large print (LP)	−0.4336	0.5191	−1.4510	0.5838	−0.84	0.4036	−0.2391
Description	−0.6437	0.4550	−1.5354	0.2481	−1.41	0.1572	−0.3549
ELA correct	0.2692	0.4801	−0.6718	1.2103	0.56	0.5750	0.1484
Science correct	−0.1899	0.5854	−1.3373	0.9575	−0.32	0.7456	−0.1047
LP * description	0.5619	0.4130	−0.2476	1.3714	1.36	0.1737	0.3098
LP * English	−0.2113	0.5024	−1.1960	0.7734	−0.42	0.6740	−0.1165
LP * science	0.3964	0.5914	−0.7628	1.5556	0.67	0.5027	0.2185
Description * ELA	−0.0058	0.3956	−0.7813	−0.7696	−0.01	−0.9883	−0.0032
Description * science	−0.1360	0.4345	−0.9876	0.7156	−0.31	0.7543	−0.0750

Effect sizes were calculated on the odds ratio (parameter estimate) using the formula suggested by Chinn (2000).

For students with visual disabilities who read braille, there were a total of 252 observations that contributed to the analysis—for 117 of these observations, the student response was correct, and for 135 observations, the student response was incorrect. Mathematics questions in the tactile graphics condition were selected as the baseline (see "intercept" in Table 7), and the parameters of the analysis consisted of responses to the science and ELA questions; presence of description; use of audible image description with tactile graphics; and interactions among these variables. Grade level was not included because the numbers of braille readers per grade level were so small (ranging from three in grades five and eight to a maximum of seven in grade three). The results are presented in Table 7.

The results of this analysis indicated that students with visual disabilities who read braille were 1.2040 times more likely to respond correctly in the audible image description condition ($p = .0277$, *E.S.* = .6638). They were also 1.0594 times more likely to respond correctly to ELA questions ($p = .0463$, *E.S.* = .5841). Unexpectedly, the odds of responding correctly to mathematics questions in the tactile graphics only condition (baseline) were significantly poorer (−.9163, $p = .0285$, *E.S.* = −.5052). None of the other parameters were significant. The audible image description condition for braille readers had a significant positive effect on the likelihood of responding correctly.

Discussion

This study is the first to examine audible image description as an accommodation in assessment environments, and it involved 295 students in grades three through eight in three states. As such, the results should be considered preliminary.

Students with visual disabilities who read braille were more likely to obtain a correct answer when audible image description accompanied the question. Surprisingly, mathematics questions in the tactile graphics condition (baseline) significantly decreased the likelihood of a

Table 7
Analysis of GEE parameter estimates for students with visual disabilities who were braille readers.

	Empirical standard error estimates						
Parameter	Estimate	Standard error	95% confidence limits		*Z*	*Pr* > [*Z*]	Effect size
Intercept (mathematics and tactile graphics)	−0.9163	0.4183	−1.7362	−0.0964	−2.19	0.0285	−0.5052
ELA correct	1.0594	0.5317	0.0173	2.1015	1.99	0.0463	0.5841
Science correct	0.9163	0.6065	−0.2725	2.1050	1.51	0.1309	0.5052
Description	1.2040	0.5468	0.1323	2.2756	2.20	0.0277	0.6638
Description and tactile graphics (TG)	0.3285	0.6142	−0.8753	1.5323	0.53	0.5927	0.1811
Description * ELA	−0.7593	0.6888	−2.1093	0.5908	−1.10	−0.2703	−0.4186
Description * science	−1.2040	0.8811	−2.9309	0.5230	−1.37	0.1718	−0.6638
Description and TG * ELA	−0.9069	0.7115	−2.3014	0.4875	−1.27	0.2024	−0.5000
Description and TG * science	−0.7638	0.8093	−2.3500	0.8223	−0.94	0.3453	−0.4211

Effect sizes were calculated on the odds ratio (parameter estimate) using the formula suggested by Chinn (2000).

correct response, with a moderate negative effect size. Drilling down further, we found that the proportion of correct responses in the audible image description condition was equal to or greater than the tactile graphics condition in every content area (see Table 8), even though braille readers in grades three through eight undoubtedly had the most experience with tactile graphics. Although we had expected to add value by pairing tactile graphics and audible image description, it was the condition least likely to result in correct responses (less than .40 for each content area), perhaps because the questions presented under this condition always took longer to answer (a mean 3.6 minutes for this condition vs. a mean 2.5 minutes for all questions).

Table 8
Braille readers' proportion of correct responses by condition and content area (n = 28).

	Content area		
Condition	Mathematics	Science	ELA
Tactile graphics only	28.6	50.0	53.6
Description only	57.1	50.0	64.3
Description and tactile graphics	35.7	39.3	39.3

Students with visual disabilities who were print readers had a greater proportion of correct responses when compared to braille readers or students with print disabilities (see Table 4). Audible image description did not impact the number of questions these students answered correctly, nor did it have an impact on the number of correct responses given by the students with print disabilities. Our conclusion is that audible image description is an unbiased accommodation during assessments. If it had provided an unfair advantage, print readers would have shown an effect for the description condition, but they did not.

Of great concern, however, is the finding that braille readers were significantly less

Table 9
Number and percentage of readers on grade level.

Reading medium	Reading on grade level *n* (%)	Not reading on grade level *n* (%)	Total *N* (%)
Standard print	23 (12.78)	157 (87.22)	180 (63.29)
Large print	51 (62.96)	30 (37.04)	81 (28.03)
Braille	17 (60.71)	11 (39.29)	28 (9.69)
Total	91 (31.49)	198 (68.51)	289 (100.00)

likely to respond correctly when tactile graphics accompanied the questions (see Table 8). The tactile graphics used in this study were extensively reviewed by experienced teachers of students with visual impairments, so we feel confident that the quality of the tactile graphics was not an issue. Yet tactile graphics were particularly unhelpful for the mathematics questions. Audible image description was at least as effective as tactile graphics for all content areas. This finding raises questions about the exposure to tactile graphics of braille readers and whether there is a need for a systematic curriculum for tactile graphics instruction beginning in preschool.

This study is not without limitations. First, the total number of braille readers was only 28. The fact that the braille readers demonstrated a better chance of responding correctly with audible image description is important, but it is possible that replicating the study on a larger scale would yield different results. Since audible image description had no effect for students who read print, whether visually impaired or not, a study focusing only on braille readers, with and without tactile graphics and with and without image description, might be a better test of the audible image description accommodation itself.

It is significant to note that teachers identified over 68% of their students as not reading on grade level (see Table 9). Braille and large print readers were more likely to be reading on grade level (61% and 63%, respectively), which may have affected their response to the audible image description—that is, the braille and large print readers may have been more successful readers to begin with, and the audible image description easily became a new strategy for them. The fact that braille readers' performance improved with audible image description, although other students with visual impairments did not improve, however, provides even greater support for audible image description as an accommodation for braille readers.

However, the discrepancy between students identified as receiving braille as a standard accommodation ($n = 39$) and those who actually used braille in this study ($n = 28$) also requires further investigation. Although it is possible that some students were in the process of learning to read braille because of a deteriorating visual prognosis, it raises the question of whether such students were receiving braille instruction as directed by their IEPs and guaranteed by IDEA. Because access to student records would have required a different level of confidentiality, we asked teachers to tell us which accommodations were permitted for instruction and assessment. Future studies that examine assessment accommodations for students with visual disabilities may want to examine students' learning media assessments, IEPs, and 504 Plans to determine permitted accommodations.

There was considerable discussion among team members regarding the best format to present image descriptions (voice or text only vs. navigable text), particularly since an earlier NCAM study had found that adult braille readers preferred to control the rate of description and the ability to review the description themselves (Gould, O'Connell, & Freed, 2008). The project staff members agreed that description presented in a navigable text format provided the best opportunity to interact with the visual information using whatever strategies were most effective for each individual learner. The benefits for older students in particular are considerable, since test items often contain complex data that can be better presented in navigable tables that students can explore using their screen readers—see the project history and research methodology for the study regarding STEM image description reported by NCAM (2009b). However, with the compressed time line of this project, we could not ensure that students with visual impairments had sufficient opportunity to develop skills in navigating tables using their screen readers. Nor did we want to eliminate potential participants because they were unfamiliar with technology. After lengthy discussion, we determined that the study was more likely to discern the impact of audible image description as a test accommodation if the research design more closely mimicked the current practice for all target populations. At the time, the least common denominator in all three states was paper-based tests. Consequently, image descriptions for this project were presented as audio files controlled by the test administrator.

One limitation of this study was the time of year when it was administered. Although great care was taken to assure that the content area questions were reflected in each state's grade-level standards, the November to February time frame may have meant that some students had not yet been exposed to the concepts prior to testing. Repeating the study at the end of the school year may result in a greater proportion of correct and faster response times, but we acknowledge that the end of the school year is not a very convenient time for teachers or students. An alternative approach might be to conduct the study at the beginning of the school year, but test the students using the previous year's content (for example, use the third grade questions for early fourth grade students).

Smarter Balanced and PARCC are commended for including image description in the construction of their assessments. However, there is considerable confusion surrounding their use (sometimes using "image description" and "human reader" interchangeably), leaving the decision about the relevance of the image to test administrators, and requiring that the accommodations used on the tests be specified in the IEP or 504 Plan. If accommodations are supposed to level the playing field, then all graphics should be accommodated in audible description and navigable text according to the student's need and preference, without consideration of relevance. No image should be left to the test administrator to decide which elements are important or relevant. These kind of decisions could result in non-standard administration of the assessments and potentially give some students an advantage not available to all.

Conclusion

Based on the results of this study, audible image description is an unbiased accommodation that assisted students who were braille readers in responding correctly to assessment questions containing graphics. Audible image description as an accommodation for braille readers was at least as effective as (and sometimes better than) the standard tactile graphics accommodation, for all content areas. Yet audible image description did not significantly affect the proportion of correct responses either for students with print disabilities or students with visual disabilities who were print readers. Particularly because audible image description offers the ability to standardize the description of graphics without giving away the correct response, we recommend that it be permitted on statewide assessments and urge state departments of education to approve its adoption. We also suggest that the national assessment consortia standardize image description, so that every student receives the same content, to maintain the integrity of the test.

This project resulted in written guidelines for audible image description, which are available from NCAM (2009a). We recommend that these guidelines, rather than the guidelines written for educational video and theater productions, be used because they specifically address print or digital images. NCAM has also recently published an excellent guide, *Item Writer Guidelines for Greater Accessibility* (Freed et al., 2015), based on its long history of research and development in all forms of description.

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