Effects of Video Adaptations on Comprehension of Students with Intellectual and Developmental Disabilities

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This study investigated the effects of alternative narration, highlighted text, picture/word-based captions, and interactive video searching features for improving comprehension of nonfiction academic video clips by students with intellectual and developmental disabilities (ID/DD). Combined multiple baselines across participants and alternating treatment designs were employed to evaluate the factual comprehension by five postsecondary participants with ID/DD. Comprehension was measured by the number of correct oral responses after watching regular, nonadapted videos in the baseline phases, as well as after watching adapted videos and after searching videos for answers via hyperlinks in the treatment and maintenance phases. Findings included: (a) the participants improved their factual comprehension of video content significantly after viewing videos modified with alternative narrations and various captioning adaptations, which resulted in additional significant improvements after students had an opportunity to search the video for answers and adjust their original oral responses; (b) the participants performed equally well regardless of the type of captions (highlighted text or picture/word-based); and (c) there was no significant difference in participant comprehension between motion videos and static images. Adapted videos offer innovative solutions for legally required access and active participation of students with intellectual and developmental disabilities in grade- and subject-linked academic curriculum.

Major laws on educational provisions for students with disabilities now mandate full access and active participation of all students, including those with intellectual and developmental disabilities (ID/DD), in the general education curriculum. The learners are expected to receive content-based instruction and make progress in academics (Browder et al., 2004; Dymond & Orelove, 2001). The stipulation of challenging content-based academic instruction for students with disabilities is sustained by requirements to include them in high-stakes testing (Defur, 2002). Even those students who pursue alternate assessment procedures due to their disabilities must target academic curriculum in all subject areas (Cushing, Clark, Carter, & Kennedy, 2005; McLaughlin & Thurlow, 2003). Under the pressure of quickly adjusting to new mandates, teachers who were surveyed by Agran, Alper, and Wehmeyer (2002) expressed reservations about the feasibility and efficiency of such content-based instruction, especially for students with low-incidence disabilities. In effort to raise expectations and learning outcomes, educators are searching for new evidence-based, effective instructional strategies for including their students with ID/DD in meaningful academic education (Agran, Cavin, Wehmeyer, & Palmer, 2006; Browder, et al., 2007; Wehmeyer, 2006).

Assistive technology (AT) offers an array of items and computer-based programs that provide necessary accommodations and opportunities for students with special needs to participate in the general education curriculum along with their peers (Hasselbring & Glaser, 2000; Wehmeyer, Smith, & Davies, 2005). However, the use of AT with students with more moderate ID/DD has been somewhat limited to the devices and solutions that provide them with access to educational environments and assist in performance (Wissick, Gardner, & Langone, 1999). In fact, a majority of existing AT products for content-based (e.g., literacy) instruction appear to be either too complex or age inappropriate, especially for older students with ID/DD. This may cause problems, given that students are expected to be engaged in the same grade-level academic activities as their peers, utilizing typical general education material (Browder et al., 2007; Flowers, Browder, & Ahlgrim-Delzell, 2006).

Due to the increased availability and familiarity, television and video may be the most frequently used technologies in the classroom. Regardless of whether they use it to replace or supplement the instruction, educators utilize video widely to teach various behaviors and skills to students with different abilities and needs. Indeed, the capacity of video to focus students' attention on relevant stimuli and its repetitiveness, controllability, and intrinsic motivation was determined to have a positive effect on the acquisition and maintenance of various skills by students with intellectual disabilities (Hine & Wolery, 2006; Reagon, Higbee, & Endicott, 2007).

Literature Review

Video Instruction

The most recent research on using video for educational purposes with students with intellectual and developmental disabilities has been focused on integration of video in preparing individuals of different ages for more independent and successful lives. Video instruction for students with ID/DD involves several formats of video delivery: video modeling (e.g., Kroeger, Schultz, & Newsom, 2007), prompting and priming (e.g., Cannella-Malone et al., 2006), simulations (e.g., Alberto, Cihak, & Gama, 2005), self-modeling (e.g., Hitchcock, Prater, & Dowrick, 2004), and interactive computer-based video programs (e.g., Mechling & Ortega-Hurndon, 2007). Different formats of video instruction have been used for teaching appropriate social behaviors and communication skills as well as receptive and expressive language (e.g., Kroeger et al., 2007; Reagon et al., 2007). Video has been used to demonstrate behaviors and tasks so that individuals with ID/DD can imitate and practice skills such as imaginative pretend play, daily living skills, and employment tasks (Cihak, Alberto, Taber-Doughty, & Gama, 2006; Nikopoulos & Keenah, 2007; Van Laarhoven & Van Laarhoven-Myers, 2006). Some researchers have relied on combining the scientifically proven effective video medium with potential reinforcers or interactive elements. Students with ID/DD have demonstrated an improved performance in purchasing and job acquisition skills after interacting with on-screen elements embedded in video-based computer programs (Ayres & Langone, 2002; Ayres, Langone, Boone, & Norman, 2006; Mechling, 2004; Mechling & Ortega-Hurndon, 2007).

Thus, the educational objectives targeted in most video-based research for individuals with ID/DD include acquisition of imitative concrete behaviors. Basic academic skills (e.g., word recognition) were introduced only to students with mild developmental disabilities and younger learners (Hitchcock et al., 2004; Kinney, Vedora, & Stromer, 2003; Lee & Vail, 2005). As an exception, video was shown to be effective in teaching students with moderate to severe intellectual disabilities to read community-based sight words and training them in the photograph recognition skills required for the successful use of augmentative and alternative communication devices (Mechling, 2004; Mechling & Langone, 2000). While demonstrating the potential to benefit students with ID/DD, these studies also point to the lack of research on the integration of video interventions into academic content-based education.

Anchored Instruction

The union of grade-level content and interactive video-based instruction is possible through another strategy called anchored instruction (AI). AI, conceptualized by the Cognition and Technology Group at Vanderbilt University (CTGV), incorporates elements of situated learning and cognitive apprenticeship (CTGV, 1996). Designed around video-based anchors, AI requires learners to generate and solve realistic problems by searching for all necessary information embedded in the video. A few studies explored applications of AI with students with ID/DD. Elements of AI were incorporated into instructional strategies aiming to assist students with acquisition of social and functional skills. They provided individuals with meaningful contexts that allowed interaction with the environment (Ayres & Langone, 2002; Simpson, Langone, & Ayres, 2004). The lack of research on using AI for teaching academic content to students with ID/DD may be attributed to its complexity. Based on the existing literature, however, it is possible to hypothesize that these students may benefit from interactive video instruction if the presentation and content are adapted to address their abilities and needs.

Video Adaptations

One of the most commonly used strategies for improving comprehension and retention of video content is closed captioning (CC). While originally designed for individuals with hearing impairments, CC is now used widely for teaching reading and listening skills to children and adults (Linebarger, 2001; Shea, 2000). Despite the argument that it could be a distraction, CC also has been determined to be an effective and unobtrusive strategy for teaching reading to students with learning disabilities (Koskinen, Wilson, Gambrell, & Neuman, 1993; Meyer & Lee, 1995). In the current study, CC was used to support the comprehension of video content rather than to enhance reading ability (Jones, Long, & Finlay, 2007).

The benefit of redundancy in the presentation of content via visual (e.g., captioning) and auditory (e.g., soundtrack) stimuli may be enhanced when combined with highlighting the captions synchronized with the narration. This strategy acts to focus learners' attention on the words (Hecker, Burns, Elkind, Elkind, & Katz, 2002; Pisha & Coyne, 2001). Moreover, since students with ID/DD may experience difficulties reading even simplified text, captions were further adapted to include picture symbols associated with each word. Picture symbols have been used successfully to provide access to printed materials for individuals with severe reading difficulties (Detheridge & Detheridge, 2002; Jones et al., 2007; Slater, 2002). Therefore, picture/word-based captions have the potential to support students with ID/DD, anchoring their comprehension of the video content in easy-to-understand line drawings.

However, with multiple visual enhancements, learning from adapted videos may be hindered by cognitive overload. Research shows that multiple inputs presented through the same channel (visual or auditory) can result in a split attention effect (Chandler & Sweller, 1992; Mayer & Moreno, 2003). Thus, presenting a motion video clip along with simultaneous highlighted or picture/symbol-based CC may create twice the demand on the visual channel and may exceed the cognitive capabilities of students. Few existing studies compared responses of students with ID/DD to static images versus motion videos (Alberto et al., 2005; Cihak, et al., 2006). While all existing studies found equal effectiveness of static images and motion videos, the limited stimuli in the form of images supposedly promoted students' attention and memory abilities. Further research is needed to determine how the cognitive processing load can be affected when using CC over motion clips as opposed to over static images of essential parts of the video.

Overall, highlighted text (HT) and picture/word-based (P/W) captions added to videos or static images may help to focus students' attention on the key elements and may act to anchor student comprehension and aid in the retention of the video content. In addition, interaction with the motivating video format while searching clips for answers in response to researcher's prompts may allow students to be more involved in and inspired by their learning.

Purpose of the Study

The existing research indicates that students with ID/DD may benefit from video-based instruction enhanced with various adaptations. However, it is still unknown whether adapted video techniques could be included as an appropriate strategy to ensure access and active participation of learners with disabilities in the general education curriculum. Thus, the purpose of the study was to determine the effects of various types of captioning (HT and P/W), alternative narration, and prompted interactive video searching on factual comprehension of nonfiction academic video clips by students with ID/DD. In addition, this study investigated whether there was a difference in efficacy between the video clips and the still images taken from the video accompanied by captioning adaptations. The specific research questions in this study included:

1. Do alternative narration and captions impact video content comprehension by students with ID/DD?
2. Do students with ID/DD further improve video content comprehension after prompted interactive video searching for answers?
3. Do two different captioning adaptations (HT and P/W) produce differential effects on video content comprehension?

4. What effects do motion videos versus static images taken from the clip have on comprehension by students with ID/DD?

Method

Participants and Setting

Students from the postsecondary program designed for young adults with ID/DD at a major northeastern university participated in this research study. The program incorporates academic instruction in content areas with practical training in employment and independent living skills. Students were chosen based on the following criteria: males or females between the ages of 19–25, who were identified as having an ID/DD; students enrolled in the program during the 2007–2008 academic year; and students who agreed to participate by providing personal informed/parent consent. Furthermore, participants' prerequisite skills for participation in the study included: ability to attend to a task for at least 15 minutes; ability to respond orally to a question; visual ability to view video images; auditory ability to hear questions and follow verbal directions given by the researcher; and motor ability to select hyperlinks in the program using a standard mouse. Two male and three female students participated in the research study. (See Table 1.)

Student V. Student V's distractibility concerns were addressed in this study through varied, shorter videos incorporating kinesthetic learning activities. Her articulation problems and slight hearing loss in the left ear did not interfere with watching the videos and answering the questions.

Student N. Student N's deficits in receptive and expressive language became apparent in his difficulty in following oral directions, articulation problems, and speech intelligibility due to omission, distortion, and substitution of sounds. Student N knew most of the letters but was not consistent in recognizing them. He had limited experience working with a computer but had no difficulty using a mouse, which had been one of the prerequisites for the research study.

Student G. Student G had difficulty enunciating words clearly and it required time to become familiar with his speech patterns. He also tired easily, had a short attention span, and at times became lethargic in class. Student G's listening comprehension was deficient, but he exhibited relatively strong visual recall of information.

Student C. Student C was identified with multiple disabilities, including cognitive disability, speech language impairment, and other health impairments (Type II Diabetes). Student C exhibited an auditory processing

Table 1

Demographic Data on Participants

Participants	Gender	Age	Ethnicity	Primary Disability	Ancillary Disability	IQ	Reading level GE
Experiment 1							
Student V	F	23.1	WH	DS	ADD/SLI	62**	3.0
Student N	M	24.8	WH	DS	SLI	40*	K
Student G	M	19.9	WH	DS	SLI	53**	5.5
Student C	F	24.8	WH	Multiple	SLI	52**	2.0
Student K	F	19.3	AA	SLD		72**	7.5

Note: Age = at the beginning of the study; IQ = Full Scale Intelligence Quotient; GE = Grade Equivalent; WH = White; AA = African American; DS = Down Syndrome; SLD = Specific Learning Disabilities; Multiple = Multiple Disabilities; ADD = Attention Deficit Disorder; SLI = Speech Language Impairments; * = Stanford-Binet Intelligence Scale; ** = Wechsler Adult Intelligence Scale; *** = Wechsler Intelligence Scale for Children deficit, expressive/pragmatic language difficulties, mild hearing loss, and weak vision. Her parents noted that ability test scores were much higher when she was tested using nonverbal language.

Student K. Despite her high ability levels, Student K was chosen to participate in this research study due to her processing disorder. Her reading comprehension skills were characterized as erratic and averaged at approximately the sixth grade level. Student K continuously expressed her desire to learn how to "understand what she reads."

All intervention sessions were conducted in the room allocated for the program, with the researcher monitoring the process and administering comprehension tests. The room (approximately 8 feet x 10 feet) contained a desk with a laptop computer. During data collection, a student sat at the computer watching video clips. The researcher was situated to the right of and in close proximity to the student.

Research Design

This research study employed two single-subject designs: multiple baseline and alternating treatments. Multiple baseline across participants was used to demonstrate a functional relation between the introduction of adapted video clips and an increase in the number of factual comprehension questions answered correctly. Alternating treatments design during each treatment phase was used to compare the relative effectiveness of specific video formats (e.g., adapted motion videos versus adapted static images with narration taken from the video) in increasing video content comprehension. Direct and systematic replication across participants was used to control for any extraneous variables and to establish stronger functional relations between the variables. Replicated and staggered baseline conditions, randomized exposure to alternating treatments, and return to baseline strengthened the power and experimental control in this study.

Dependent Variables

Comprehension of video was measured by the number of questions the participants answered correctly after viewing the video clip (adapted or not). Accuracy data on three factual questions were collected on a trial-by-trial basis. First, the participants were asked to produce an oral answer in response to questions presented by the researcher after they viewed videos in all baseline and treatment phases (oral Level 1 responses). The response was counted as correct if the participant correctly answered a comprehension question asked by the researcher within 30 seconds of the stimuli; partially correct if the participant provided an answer that was partially accurate—i.e., was similar to the correct answer but not clearly stated, or entailed an accurate idea but did not match a predetermined correct answer; or incorrect if the participant incorrectly answered a question or verbally expressed that he/she did not know the answer. Students then had an opportunity to use hyperlinks to go back in the video and view segments containing correct answers for those questions they answered partially correctly or incorrectly during oral questioning. Students searched the video in response to the researcher's prompting. After viewing the segment, they again answered the questions presented by the researcher (oral Video Searching responses).

Materials

Both the materials and the research procedures were validated through a two-tiered process. First, the sample videos and the procedures were pilot tested with the program graduates. An expert panel, which included the program director and coordinator, reviewed each script (whether original or adapted) to determine the appropriateness of the video and the research questions to the students' abilities and needs. Changes were made as necessary.

The primary materials in this study included academic nonfiction video clips. Editable video clips were compiled from the Discovery Channel's unitedstreaming (**http://streaming.discoveryeducation.com**) service. It offers a large selection of Web-based educational videos that are correlated with state standards in all academic areas. Videos selected for this study were aligned with the Virginia Standards of Learning (SOLs; Virginia Department of Education, 2010); topics covered in the LIFE courses; and based on the current trends in society (e.g. global warming, presidential elections, etc.) Based on pilot testing, it was decided to segment longer videos into shorter 1.5–2-minute clips.

Baseline condition. In order to establish the context for further analysis, participants viewed the original, nonadapted video clips in both baseline phases (Phases I and III), and then responded to comprehension questions. The narration of the video content remained in its original form during the baseline phases. Following the video clip, participants saw a single still video frame on a computer screen with a black background and the title, "Questions," supported by a picture of a question mark. At that time, the researcher asked three factual questions with a 30-second delay (controlled by a stopwatch) between the questions to allow the participant to answer.

Treatment conditions. Treatment conditions required participants to view adapted video clips and answer factual questions. Narration of all videos utilized in the treatment conditions was altered to meet the intellectual level of the participants, averaging at the fifth grade level. Microsoft Word readability statistics were used. Cognitive rescaling of the text was achieved by cutting the word count, removing all passive voice sentences, and converting clauses into short declarative sentences, thus altering the cognitive challenge involved (Edyburn, 2002). The alternative narration was recorded using "natural/real" synthesized voices of the WYNN 5.0 program.

The captions enhancing auditory comprehension of the video content were created using Camtasia Studio Screen Recorder software. After the altered narration was recorded and added to each video segment, the captions corresponding to that narration were placed at the top of the video screen. The captions presented one sentence per line in mixed (lower case and upper case) black 28-point Arial letters on a solid white background. During HT captioning conditions, words were highlighted in yellow as they were spoken. In the case of P/W captioning, words in the captions were accompanied with picture symbols and were not highlighted. P/W captions were created using Writing with Symbols (WWS) 2000 program.

Study participants alternated between the motion video clips with highlighted text captions (V-HT) and the narrated static images taken from the video with highlighted text captions (I-HT) positioned at the top of the screen in the first treatment (Phase II). In the second treatment (Phase IV) participants were provided motion video clips with picture/word-based captioning (V-P/W) and narrated static images taken from the video and supported with picture/word-based captioning (I-P/W). The average rate of caption presentation was 80 words per minute, according to the preferences established during pilot testing.

After participants responded to all questions in the treatment phases (Phases II and IV), they were offered an opportunity to search the video for answers to the questions they had answered partially correctly or incorrectly. During these phases, participants saw a single video frame with three phrases on a white background that corresponded to each comprehension question. Each phrase was accompanied by a hyperlink in the form of a red arrow. After clicking the hyperlink with a mouse, the participants were taken to the segment of the video that corresponded to the selected phrase and contained the answer to the target question.

Procedures

Prior to the beginning of the study, the researcher introduced the participants to the video adaptations. The 15–20 minute small-group trainings took place in the research setting. The researcher used the pre-established training script to introduce students to the project and the different kinds of videos. Prior to the beginning of data collection, participants were assigned randomly at two levels. First, they were assigned to a number from 1–5 to determine the starting order of treatment. A predetermined five-point separation between the first and the second students, and then three points for each subsequent participant, separated each individual's entry into the treatment phase. Then, alternating treatments were assigned randomly to observation times or the order in which students alternated between the two intervention formats. Regardless of the condition, each participant was given a verbal instruction to view the video (adapted or not) at the beginning of each session. The researcher prompted attention to the screen if necessary. Following the video, the researcher asked three questions. Participants were encouraged to respond orally (oral Level 1 responses). The researcher and the reliability observer (when applicable) recorded the number of questions answered correctly, partially correctly, and incorrectly. If a participant did not make an attempt to respond within 30 seconds of the stimuli, the next question was asked.

Two baseline conditions (Phases I and III) were terminated after the participants had a chance to watch the video and respond orally to the comprehension questions. In two treatment conditions (Phases II and IV), a participant was taken to the video searching still frame after he/she attempted to answer all the questions orally. At this time, if a student answered all the questions correctly, the researcher delivered nonspecific verbal praise and announced the end of the session. If a student answered any questions partially correctly or incorrectly during oral Level 1 questioning, he/she was able to search the video for correct answers using the red arrow hyperlinks.

The researcher announced which question needed to be corrected. No additional prompting was delivered. It was a participant's responsibility to choose the correct hyperlink from the numbered list and activate it with a mouse click. If a student selected a wrong link, the answer to that question was recorded as incorrect. Upon successful hyperlink activation, a participant viewed a segment of the video featuring the correct answer. Following the video segment, the researcher repeated the question and allowed a participant to answer it again (oral Video Searching responses). If a student repeated the sentence from the segment mindlessly, the researcher asked the participant to elaborate on his/her response.

The maintenance probes utilizing video adaptations shown to be the most effective and/or preferred by the participants were conducted following the end of the study. Three data probes were collected for each participant five days after the last day of interventions. Maintenance data were collected in the same setting following the same procedures described previously.

Interrater Agreement, Fidelity of Treatment, and Social Validity

Data for evaluating both fidelity of treatment and interrater reliability were collected simultaneously by the independent observer during a randomly selected 33 percent of the sessions. Following the training on operational definitions of target behaviors and the recording system, the independent observer collected the data on participants' responses independently and simultaneously with the primary researcher. The total agreement formula was used: S ÷ L x 100%, where S is a smaller total and L is a larger total of response occurrences. The coefficient of agreement between the researcher and observer was 87% for oral Level 1 responses and 92% for oral Video Searching responses, averaging 89.5% across all questioning levels. The integrity of interventions was sustained by maintaining the consistency of the video content across the participants and conditions. The researcher also used pre-established scripts for the training and prompting during the sessions. Fidelity of treatment was derived by dividing the number of observed researcher's behaviors by the number of actions predetermined by the intervention script multiplied by 100. It was determined at 100%.

At the end of the study, semistructured interviews were conducted. Participants were asked for their perceptions of usefulness and effectiveness of video adaptations. Their opinions about the video without adaptations also were solicited. Thus, data regarding the social impact of the intervention, participants' attitudes toward the research procedures, and outcomes were collected.

Data Analysis

The efficacy of different video adaptations was determined through a visual analysis of data (e.g., mean levels between phases, the rapidity of change, and within/across phases variability of data). In addition, the percent of data points that did not overlap with the highest data point (PND scores) was calculated to establish whether the adapted videos were effective. Due to high variability within and across the phases for each of the participants, the visual inspection of data in this study was supplemented by objective randomization tests. With the help of special software intended for single-subject designs (Todman & Dugard, 2001) and SPSS for Windows 15.0, the test statistic was obtained to determine the probability of having a difference between a baseline and each of the adaptations within and across the participants by chance. Adapted Design 3–AB Multiple Baseline test was used to establish whether adapted videos resulted in better performance than regular videos. The Design 5a - Single Case–2 Randomized Treatments test was run to determine which video format (motion videos with captions or static images with captions) as well as which captioning condition (highlighted text or picture/word-based captions) was more effective for each participant. However, the decision about the effectiveness of interventions in the present study was made only if there was an agreement between visual and statistical analyses. Consumer satisfaction was examined through qualitative analysis of the semistructured interviews.

Results

As mentioned previously, after a participant provided oral responses (oral Level 1 questions) in each treatment phase, he/she was offered an opportunity to search the video for answers to any question answered partially correctly or incorrectly and provide a new answer orally (oral Video Searching level questions). The two graphs share the same baseline data but include only oral Level 1 responses (see Figure 1) or only oral Video Searching responses (see Figure 2) in treatment phases.

Adapted and Interactive Videos and Content Comprehension

All participants displayed a relative increase in the number of correct responses after videos were enhanced with alternative narration and various captions. Factual comprehension further improved after the participants had an opportunity to search the video for answers in response to the researcher's prompting. There was a detectable increase through visual inspection in the mean lines from the initial baseline (Phase I) to the first treatment (Phase II) for all five participants (see Figure 1) as they viewed videos adapted with alternative narration and HT captioning. The level of increase for Student K was more than 1 point on a 3-point scale, while Students V, N, G, and C improved by at least 0.5 point on average. However, due to elevated data points during several of baseline sessions, the first treatment data point for all five participants always overlapped with the baseline points, indicating the lack of the immediacy of effect. The high variability of data also determined the low percent of nonoverlapping data (PND = 36.6%) between the initial baseline (Phase I) and the first treatment (Phase II), based on students' oral Level 1 responses averaged for all the participants (Figure 1). According to the approximated Design 3 (AB Multiple Baseline) randomization test, the proportion of 2,000 randomly sampled data divisions, giving the accuracy difference in the predicted direction at least as large as the experimentally obtained difference was 0.0005. Therefore, the obtained difference between factual comprehension accuracy after viewing regular videos and videos adapted with alternative narration and HT captions (oral Level 1) was statistically significant ($p < 0.05$; one-tailed).

The level of accuracy of students' responses decreased to the initial baseline level when the intervention was withdrawn in the second baseline (Phase III). This established a clear functional relation in the treatment design. In fact, more stability was noted in the second baseline. The positive outcomes of adapted videos on the participants' factual comprehension (oral Level 1 questions) were reinstated during the second treatment, where alternative narration and P/W captioning were introduced. The analysis of data between the second baseline (Phase III) and the second treatment (Phase IV) confirmed the obvious immediacy of treatment effect for Students V, N, G, and K, along with the significant level change for all five participants. Despite the 54% PND score suggesting questionable effectiveness of P/W captioning on the oral Level 1 responses, the randomization tests showed statistically significant improvements in students' performance with the adapted videos ($p < 0.05$).

A more significant increase in the mean lines was observed when students' responses in the baseline were compared to their oral responses after searching the video for answers (Video Searching Level Figure 2). In addition to the visually obvious increase in the mean lines for all participants, Students V, N, C, and K demonstrated an immediate change when the first data point in the treatment Phase II did not overlap with the initial baseline (Phase I). While Student G did not demonstrate an immediate change, he was able to answer correctly on average 1.66 factual questions more after video searching as compared to his baseline responses. The significance of interactive video searching effectiveness was reflected in the 86% PND score averaged for all the participants and statistically significant randomization tests ($p < 0.05$).

More substantial and visually significant changes in the number of correct responses were achieved by each student in the second treatment (Phase IV Figure 2) as compared to the second baseline (Phase III) after they searched the video for answers (oral Video Searching Level) with 89% PND across the participants. The effectiveness of video searching intervention in this phase also is supported by the randomization tests results ($p < 0.05$). The increased mean levels were sustained on both questioning levels (oral Level 1 and oral Video Searching Level), as participants entered the maintenance phase.

Overall, despite low PND scores for some participants, visual inspection of data mean levels supported by the results of the randomization tests suggests that both

Figure 1

Accuracy of oral Level 1 responses to factual comprehension questions by all the students across the research phases.

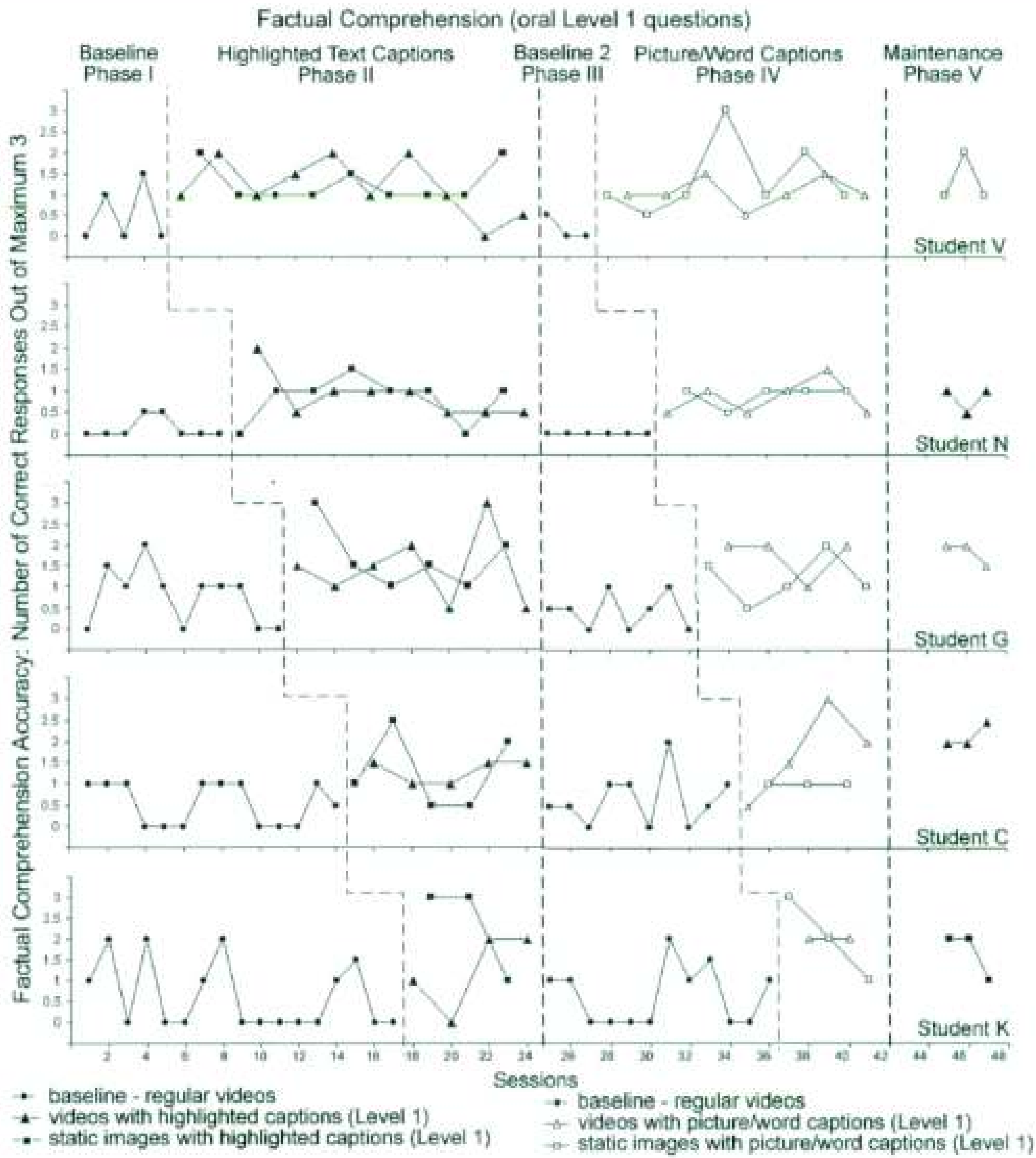
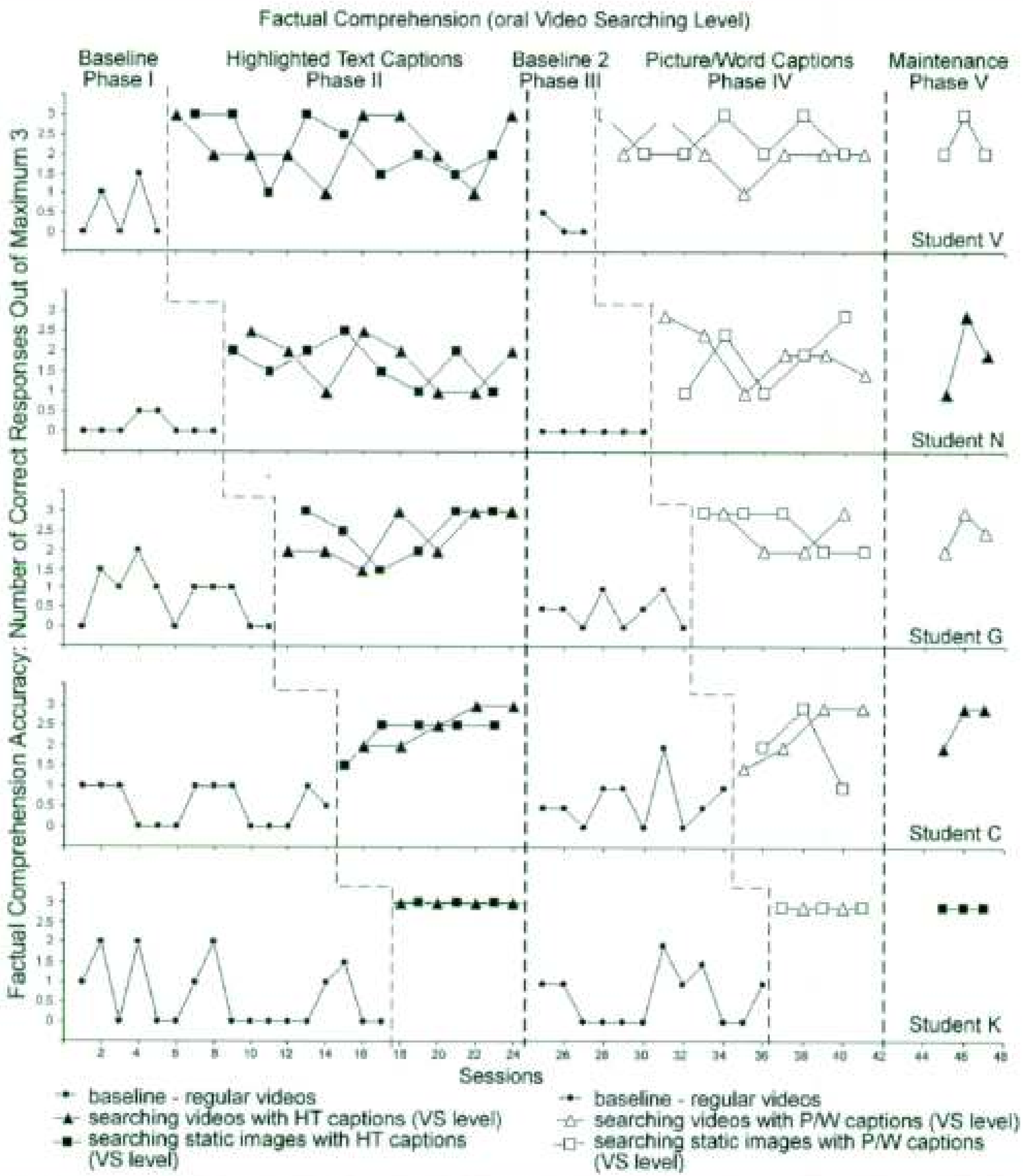


Figure 2

Accuracy of oral video searching responses to factual comprehension questions by all the students across the research phases.



captioning and video searching interventions were effective for all of the participants. The data on factual comprehension across all study phases for individual students is summarized in Table 2. The mean, standard deviation, and PND values are combined and averaged for the different video formats in each of the treatment phase in order to determine the effectiveness of adapted videos in general, without the specification of the video format.

HT Versus P/W Captions

Each participant had an opportunity to view videos adapted with alternative narration and both captioning types: HT (Phase II) and P/W captions (Phase IV). According to the visual inspection (Figures 1 and 2) none of the students demonstrated a significant difference in factual comprehension of the video content enhanced with different types of captions. The visual results were corroborated by the randomization tests, which demonstrated that there was no statistically significant difference in accuracy outcomes after viewing videos with HT and P/W captions.

Motion Videos Versus Static Images

During all treatment conditions (Phases II and IV), study participants alternated between adapted motion videos and adapted static images taken from the videos. These two conditions were tested to determine the impact of captioning video adaptations on the abilities of students with ID/DD to process information incoming through multiple channels (e.g., visual, auditory). The results indicated that most of the students did not demonstrate

Table 2

Means, Standard Deviations, and PND Scores for Factual Comprehension Accuracy Measured by Three Oral Factual Questions in Experiment 1

Participant	Baseline Phase I	HT Captions Phase II	Video Searching Phase II	Baseline Phase III	P/W Captions Phase IV	Video Searching Phase IV
Student V						
$m_c(sd_c)$	0.5 (0.7)	1.24 (0.6)	2.18 (0.8)	0.17 (0.3)	1.21 (0.6)	2.21 (0.6)
PND_c		26%	74%		86%	100%
Student N						
$m_c(sd_c)$	0.13 (0.2)	0.84 (0.5)	1.72 (0.6)	0.00 (0)	0.86 (0.3)	1.95 (0.8)
PND_c		63%	100%		100%	100%
Student G						
$m_c(sd_c)$	0.77 (0.7)	1.54 (0.8)	2.43 (0.6)	0.44 (0.4)	1.44 (0.5)	2.56 (0.5)
PND_c		15%	54%		56%	100%
Student C						
$m_c(sd_c)$	0.54 (0.5)	1.30 (0.6)	2.40 (0.5)	0.65 (0.6)	1.43 (0.8)	2.21 (0.8)
PND_c		50%	100%		14%	43%
Student K						
$m_c(sd_c)$	0.62 (0.8)	1.71 (1.1)	3.0 (0)	0.63 (0.7)	2.00 (0.7)	3.00 (0)
PND_c		29%	100%		20%	100%

Note: $m_c(sd_c)$ = Means and standard deviations combined for all data points in each phase; PND_c = Percents of nonoverlapping data combined for all data points in each phase any substantial differences in accuracy when viewing adapted videos or static images (see Figures 1 and 2). In fact, the mean levels were nearly identical for four out of five participants, regardless of whether they worked with adapted motion videos or static images. The only student who showed a difference of at least one correct response on a 3-point scale was Student K, whose factual comprehension in Phase II (oral Level 1 questions, Figure 1) was better with still images adapted with HT captions. In addition, no statistically significant differences were found for any of the participants between the adapted motion videos and adapted static images.

Social Validity

Results of the interviews indicated that all the participants had positive feelings about the research project. They all liked viewing different videos and enjoyed learning "new stuff" enhanced by the fact that videos "helped memory." Two students (Students V and G) preferred P/W captions because picture symbols "helped [them] understand what video was about." Students N, C, and K favored HT captions because the "yellow highlight moved" from word to word and that type of caption did not have pictures, suggesting that picture symbols could have been distracting for some students. All students reported that they looked both at the video content and at the words and/or picture symbols on the top of the screen during video viewing. However, none of the students had any preference on the motion video and/or static images. The feature that made it easier to answer questions, according to the opinions of all students, was the video searching via hyperlinks. This interactive feature was "fun" and "very helpful" to go back if a student forgot what the clip was about. Overall, 100% of the students noted that they would like to watch adapted videos in the future and would "definitely" recommend them to others.

Discussion

The efficacy of video instruction in teaching various behaviors and skills to students with intellectual disabilities (ID) is pertinent to repetitive yet motivating practice and learning without needing to read text. In turn, video adaptations in this study expanded the possibilities of universally designed, evidence-based solutions for incorporating academic content into the instruction of students with disabilities. Results from both visual and statistical analyses in this study revealed that, as compared to viewing regular video clips, students with ID/DD benefited from viewing videos adapted with alternative narration and various types of captions and especially from opportunities for active interaction with the video content.

Building on existing practices of integrating video in teaching various subjects for general education students at all grade levels (Boster et al., 2006; Linebarger, Kosanic, Greenwood, & Doku, 2004), this study expanded long-established applications of video instruction for students with ID/DD from functional skill development and teaching concrete skills to presenting academic content. In fact, even without any adaptations, video instruction can be effective for students who are visual learners and are motivated by watching television (Tardif-Williams et al., 2007). This notion may have accounted for the relatively high performances of participants in the present study across two baseline phases.

Relative improvements in content comprehension were observed for the majority of students as soon as they were introduced to videos adapted with alternative narration and various types of captions. It is not rare that educators modify materials by simplifying or shortening them, especially in content-heavy areas such as science and social studies. While script alterations prevent conclusions about the unique contribution of CC to performance gains, captions have been known to improve content recall and listening comprehension for students with learning difficulties (Linebarger, 2001). The visual analysis of data indicates the relative similarity between HT and P/W captions. The value of visual presentation of auditory input by highlighting text, fostering students' attention, and blocking distractions as discussed by Hecker et al. (2002) was corroborated by improvements in comprehension accuracy, especially for a student diagnosed with attention deficit disorder (ADD). Visual presentation also was one of the comments in the participants' interviews; they indicated that the "yellow highlight" helped them follow and read the captions. However, several students (e.g., Students G, and K) scored better, although not statistically significant, in many experiments with P/W captioning. An important factor that may have skewed the effectiveness of P/W captions on comprehension accuracy was that none of the participants in this study had extensive experience with Mayer-Johnson picture symbols. While used in some of their classes, most students were novices in the use of picture symbols. Thus, there is a premise that those students with disabilities who use picture symbols on a regular basis will demonstrate even greater gains and will benefit more from this type of captioning adaptation.

While the students demonstrated increased comprehension of video content after the videos were enhanced with alternative narration and captioning adaptations, their performance accelerated even more with the introduction of an interactive video searching option. Their gains were more evident after they had an opportunity to go back in the video and view short segments containing correct answers in response to the researcher's prompt. The gains in the number of correct factual comprehension questions were detectable for all five participants and supported by statistically significant results of randomization tests. These findings are corroborated by the extensive research on the concepts of active learning and AI. Active learning has been promoted for many years to enhance traditional instruction for students of different abilities and needs (Feldman & Denti, 2004; McCarthy, 2005). From one of the earliest studies utilizing interactive video-based simulation of purchasing in a convenience store (Wissick, Lloyd, & Kinzie, 1992), to one of the most recent studies incorporating interactive video program for practicing job tasks (Mechling & Ortega-Hurndon, 2007), all researchers agree that a higher degree of interactivity enables more substantial gains in the performance of students with ID/DD. In fact, all students reported that the "searching screen" and "red arrow hyperlinks" were their favorite part of the process, thus motivating them to attend more to video content. Despite all obvious benefits, however, it is not known how students will perform when making independent decisions to search the video for answers without the researcher's prompting. Unfortunately, this may hinder the effectiveness of interactive video searching features during independent learning activities.

The results of the study did not identify any substantial differences between the motion and static video formats. Both adapted motion videos and narrated static images had an equally positive impact on factual comprehension by students with ID/DD. The randomization tests also did not find any differences that were statistically significant for any of the participants. Furthermore, none of the participants expressed strong preferences in terms of watching motion videos and/or static images during the social validity interviews. These findings are supported by limited research indicating that static images and motion videos had equal efficiency and effectiveness for students with ID/DD (Alberto et al., 2005; Cihak et al., 2006). Practically though, it may be more efficacious to use the motion video as it is rather than edit it to get static images. However, more empirical research is needed to examine the possible focusing and motivating value of motion video format (as for Student N) along with its distracting nature to students with ADD (as for Student V).

Based on social validity interviews, a majority of the participants would continue to use adapted videos and would recommend them to other students. On several occasions they expressed how much new information they were able to learn with adapted videos and how easy it was to answer questions. Thus, adapted video instruction was shown to be both enjoyable and relatively effective in improving factual comprehension of nonfiction video content for students with ID/DD.

Educational Implications

Each new educational strategy is more accepted if it finds applications for broader groups of students. The universally designed adapted videos described in this study can provide teachers with solutions to content-based instruction for students of different abilities and needs. The following principles of Universal Design for Learning (UDL) are essential in ensuring success of students with ID/DD in the general curriculum: equitable use, flexible use, simple and intuitive use, perceptible information, tolerance for error, and low physical and cognitive effort (Rose & Meyer, 2002). Almost all of these principles can be addressed with video adaptations. Such adapted videos can provide instruction to students with a diverse array of abilities, needs, and learning preferences. In fact, since video formats, alternative texts, highlighted text, closed captioning, and video searching in anchored instruction have been shown to be effective for students with mild or no disabilities, adapted videos can find a place in general education classrooms.

Limitations and Future Research

The aforementioned findings should be interpreted with caution, taking into consideration the following limitations. First, the diversity across the participants and their characteristics contributing to a high variability of data could be avoided by grouping students according to their ability levels. Second, it is unclear how the students' performance with the videos adapted with picture/word-based captions was affected by their lack of experience with picture symbols. Because adaptations to the videos included both alternative narration and captioning enhancements, it is impossible to determine how individual components contributed to the improvements in factual comprehension. Furthermore, some topics may have been more interesting for certain participants, thus skewing the comprehension results. Further research is needed to determine the effectiveness of each of these components on academic performance by students with ID/DD.

Future research on adapted video instruction also could benefit from replicating this study with school-aged students who have intellectual disabilities to ensure social validity of video integration into existing general curriculum activities. The effectiveness of various captioning adaptations (especially highlighted text captions) and interactive video searching features should be examined with other student populations as well, including students with autism, learning disabilities, etc. It also is important to replicate this study with students who use Mayer-Johnson symbols and/or any other picture symbols on a regular basis. Finally, in order to further promote the integration of adapted videos for all students, including in general education settings, it is important to research the effectiveness of captioning adaptations (whether highlighted text, picture/word-based, or standard) in clips with the original narration.

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