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# Tablet-based video modeling and prompting in the workplace for individuals with autism

Raymond V. Burke[a,b,*], Keith D. Allen[c], Monica R. Howard[c], Doug Downey[d], Michael G. Matz[e] and Scott L. Bowen[a]
[a]*The Prevention Group, Omaha, NE, USA*
[b]*University of Nebraska, Lincoln, NE, USA*
[c]*Munroe Meyer Institute for Genetics and Rehabilitation, University of Nebraska Medical Center, Omaha, NE, USA*
[d]*Northwestern University, Evanston, IL, USA*
[e]*Flying Yeti, Los Angeles, CA, USA*

**Abstract**. The current study involved a preliminary job-site testing of computer software, i.e., *VideoTote*, delivered via a computer tablet and designed to provide users with video modeling and prompting for use by young adults with an autism spectrum disorder (ASD) across a range of employment settings. A multiple baseline design was used to assess changes in rates of completion with a complex, 104-step shipping task by four participants diagnosed with ASD. Baseline data were collected on accuracy of task completion after exposure to typical job-training involving instruction, modeling, and practice. The intervention involved video modeling and prompting with a 13 minute video depicting an individual completing job responsibilities that entailed checking to make sure materials were in working order, replacing defective items, packing materials in a container, entering information into a computer, and attaching a label to a container. Results suggested that video modeling and prompting were effective in helping individuals with autism complete a multi-step shipping task. Participants and their parents gave the device and software high ratings as an acceptable treatment for adults with autism to use in the workplace and intervention that complies with universal design principles. Implications for competitive job opportunities for individuals with autism are discussed.

Keywords: Autism, assistive technology, computer tablet, employment, video modeling, video prompting

## 1. Introduction

A recent analysis of U.S. vocational rehabilitation (VR) services reported declines for individuals with disabilities in rates of competitive employment and hours worked per week, and increases in response time between application for services and employment [25]. To compound the problem for those diagnosed with autism, the number of adults with an autism spectrum disorder (ASD) entering VR programs increased 121% between 2002 and 2006 [14] while the percentage of VR closures for individuals with autism increased only 2.7% from 1 to 3.7% between 1995 and 2007 [10].

Although employment rates for adults with intellectual and developmental disabilities (IDD) are consistently lower than their neuro-typical peers [32], employment rates for young adults with autism are among the lowest for any individuals with IDD. Wagner and colleagues' summary [34] of more than 11,000 participants in the National Longitudinal Transition Study-2 reported that, at two years post high school, only 28% of individuals with autism were employed (including competitive, supported, or sheltered employment) or employed and in post-secondary education

*Address for correspondence: Raymond V. Burke, The Prevention Group, 2320 Paul Street, Omaha, NE 68102, USA. Tel.: +1 011 402 108 1324; Fax: +1 011 402 331 2729; E-mail: ray@thepreventiongroup.org.

programs compared with 36% of those with intellectual disabilities, 50% of individuals with multiple disabilities, 57% of individuals with traumatic brain injuries, 62% of those with emotional disabilities, and 77% of those with learning disabilities.

This low rate of employment for individuals with ASD is not limited to the United States. Barnard and her colleagues' [5] analysis of survey responses from more than 450 parents of adults with autism or Asperger syndrome living in the United Kingdom (65% of whom were described by parents as "medium" or "high" functioning) found that only 6% of the individuals with ASD were employed full-time and 4% were employed part-time. Consistent with Barnard's study, results from a prospective study with 120 employment-age individuals with autistic disorder or atypical autism living in Sweden, only 9% were employed [8]. Without substantial support and effort, the outlook for any type of employment (i.e., competitive, supported, or sheltered) for individuals with autism appears bleak.

One form of support that has been used to bridge the gap between unemployment and employment for individuals with IDD involves a "job coach." Job coaches often provide vocational and social support training for employment-age adults with disabilities and have been found to be effective at increasing earnings and time in employment for individuals with disabilities [19]. Job coaches provide a variety of supports within the workplace, but most often emphasize modeling, prompting, and feedback when needed [36].

Although the use of job coaches can produce individual successes, they present numerous challenges. For example, the use of job coaches is often time consuming and can involve working with employees with disabilities for up to 20 hours per week for up to 6 months [19]. Furthermore, it can be difficult to find and keep qualified job coaches [29]. There also are logistical limits on the number of individuals each job coach can support. As one VR specialist put it, "Job coaches are few and far between, and stretched to their limits." (R. Coleman, personal communication, May 27, 2010). These may be contributing factors to the low rate of employment among individuals with ASD and suggest a need for more cost-effective, wide-scale, reliable means of training and support for employment-age individuals with ASD.

One potential alternative to job coaches is to take their primary functions (i.e., modeling, prompting, and feedback) and automate them. This also makes sense for adults with ASD because modeling, prompting, and feedback have been recognized as evidence-based interventions for individuals diagnosed with an autism spectrum disorder [26]. For example, video modeling (VM), which involves watching prerecorded examples of one's self or peers, or adults demonstrating simple or complex skills, has a long history of success with individuals on the autism spectrum [15]. Nikopoulos and Keenan [27] used a 35 s video depicting a child playing with an adult or peer to teach social interactive play to children and teens on the autism spectrum. Results indicated that for four of the seven participants, there were reductions in latency to social initiation and increases in time spent in play, both of which generalized across toys, settings, and peers. A recent meta-analysis compared 38 studies to examine the effectiveness of social stories, peer-mediated interventions, and video modeling for increasing social skills among children and teens with ASD [35]. Results indicated that, of the three interventions, video modeling was the only one that met criterion for a highly effective and evidence-based practice. Bellini and Akullian's [6] meta-analysis assessed the effects of video modeling and video self-modeling in 23 studies involving children with autism and found that both interventions were effective at teaching social, academic, and daily living skills, and that results maintained across time, settings, and people.

Video modeling has been combined with other evidence-based practices to improve learning and performance of functional life skills among adults with developmental and intellectual disabilities. For example, Goodson and his colleagues [17] used VM to teach four adults with developmental disabilities how to set a table. One participant was successful at demonstrating the table setting task to criterion with VM alone. For the remaining three participants, video-based error correction (where participants watched the video a second time after a performance error) and live modeling by the researcher were added and resulted in criterion level performance by participants [17]. Rehfeldt and her colleagues [28] used video modeling, coupled with live modeling and video-based error correction after inaccurately completed task steps, to teach three adults with intellectual disabilities a 17-step process for making a peanut butter and jelly sandwich. Results indicated that after watching a 2.5 min video on a laptop computer, participants substantially increased the percentage of steps completed to criterion, and skills generalized to a new setting and maintained at one-month follow-up [28]. In another variation on the use of VM, video modeling plus VM booster sessions were used effectively to teach three teens with intellectual disabilities 10-, 11-, and 12-step processes for using an iPod to listen to music, look at photos, and watch a movie, respectively [18].

In addition to these efforts to automate modeling, other investigators have looked to automate prompting strategies. Video prompting involves having an individual watch a video segment depicting one step of a task before that individual completes the task step, and continuing this process (i.e., watch video of one task step; then complete that task step.) until all task steps are completed. For example, Sigafoos and his colleagues reported positive results when video prompting was used to teach three adults with developmental disabilities how to complete 10-step processes for making microwave popcorn [31] and wash dishes [30]. Mechling and her colleagues [24] effectively used a personal digital assistant to deliver video, audio, and picture prompts to teach three teens diagnosed with autism how to complete 19- to 25-step cooking tasks.

Recent comparisons of video modeling (VM) and video prompting (VP) suggest that video prompting may be more effective, especially with adults diagnosed with profound disabilities such as autism and an intellectual disability [11, 12]. Cannella-Malone and her colleagues [11] used a multiple probe across subjects and alternating treatments design to compare the effectiveness of VM and VP on the ability of six adults with intellectual disabilities to demonstrate 10-step processes for setting a table and putting away groceries. VP resulted in a higher percentage of correctly completed task steps when compared with VM. Cannella-Malone et al. [12] replicated their comparison of VM and VP effectiveness with seven middle school students and laundry and dish washing tasks. Findings mirrored those from their 2006 study with VP resulting in substantially higher rates of task completion than VM [12]. Similarly, Allen and his colleagues' recent study [1], involving the use of video modeling and verbal prompting to increase vocational skill use among three young adults with diagnoses of autism and intellectual disabilities, found verbal prompting to produce higher rates of skill use than video modeling. These studies in combination suggest that prompting may be beneficial when individuals have more significant impairments or when task complexity is greater than participants' intellectual capacities.

Very recently, a few investigators have begun to examine the benefits of VM as a replacement for job coaches in competitive employment settings. Allen and colleagues found video modeling to be an effective means of teaching a variety of social engagement skills to young adults with autism for use in promoting products in a large retail store [2]. A follow up study found that these skills generalized to a new, untrained setting [3]. Likewise, Van Laarhoven and colleagues [33] found VM to be effective for teaching cleaning skills to an individual with developmental disabilities working in a kennel. However, these studies represent rather simple vocational demands. Given the magnitude of the employment disparities between individuals with autism and the general public, and the potential for employment of individuals with ASD in a variety of jobs, additional studies are needed to examine whether VM and VP can be (a) flexible enough to be used *in situ* at the job site and (b) promote success in more challenging competitive employment settings.

Three recently published studies have begun to address these issues by using portable personal digital assistants (PDAs) to deliver visual prompting or video modeling in the workplace with individuals with cognitive disabilities [9, 16, 33]. Burke and colleagues [9] used an iPhone® and iPod® proprietary text cuing application to assist six individuals with autism in a 63-step mascot performance during a 45-minute fire safety presentation with elementary school children. Individuals performed a substantially higher percentage of chained behaviors correctly with the PDA-based text cuing system when compared to performances without the text cues. Davies and colleagues [16] used a PDA prompting device to help 40 individuals with cognitive disabilities complete 11- and 12-step packing tasks that involved putting products into a shipping container. Participants made significantly fewer mistakes and requests for assistance when using the PDA-based prompting system than they did without the system. In a recent study with one young man with developmental disabilities, Van Laarhoven et al. [33] used an iPod® based video prompting system to increase the percentage of steps completed when cleaning a bathroom (41 steps), mopping the floor (47 steps), and cleaning kennels (52 steps). Improvements in task performance were outstanding; criterion level of performance averaged 85% across the three tasks and ranged from 78 to 100% when the participant used the video prompting.

Although these studies begin to bridge the gap between research and real-world work environments, each has limitations. For example, Burke et al. [9] required on-site prompting by someone functioning as a job coach, thereby potentially limiting employee independence in the workplace. Davies et al. [16] tested participants' ability to complete a limited number of task steps which may not represent the complexity and duration of many competitive jobs. Outcomes from

Van Laarhoven et al. [33], although laudable, represented an average performance criterion (85%) that is problematic in most competitive jobs where less than 100% of task completion causes problems for the business owner and customer. Furthermore, none of the three studies assessed universal design features that have demonstrated effectiveness with individuals with cognitive and developmental disabilities [38]. These limitations need to be addressed if the increasing numbers of individuals with ASD are to be successful in competitive employment settings.

The purpose of the current study was the preliminary job-site testing of computer software delivered via a computer tablet that provides users with video modeling, video prompting, and feedback to enhance job training and job performance in a wide range of employment settings.

## 2. Method

### 2.1. Participants

Four young men, age 19 to 28 years, who are on the autism spectrum and unemployed, participated in this study. Zeke, a 22-year-old Asian American male with a diagnosis of Asperger Syndrome, had overall cognitive functioning in the borderline range (Composite = 70) and adaptive skills ranging from typical (Conceptual = 85) to significantly delayed (Social = 68). Tom, a 21-year-old European American male with a diagnosis of autism, OCD, ADHD, and Tourette Syndrome, had overall cognitive functioning in the above average range (Composite = 121) with adaptive skills within the borderline range (i.e., 76 to 81). Ric, a 19-year-old European American male, had a diagnosis of Asperger Syndrome and a severe visual impairment. His overall cognitive functioning was found to be in the typical range (Composite = 107) while his adaptive skills were all found to be within the significantly delayed range (Conceptual = 65, Social = 64, Practical = 61). Finally, Dan, a 28-year-old European American male with a diagnosis of Asperger Syndrome, had an overall cognitive functioning within the typical range (Composite = 85), however his adaptive skills ranged from borderline (Conceptual = 77, Practical = 75) to significantly delayed (Social = 64). All participants were unemployed and all but Tom lived at their parents' home; Tom lived in a community-based group home.

### 2.2. Setting and materials

#### 2.2.1. Setting

The study took place in a 20,000 square foot manufacturing and shipping warehouse in a Midwestern city. The facility employs 18 full-time staff who possessed a wide range of technical, design, production, and business skills. The company ships products throughout the U.S. and abroad.

A manager and a key employee of the manufacturing company who were responsible for shipping products to customers were interviewed to help select a competitive job for testing the tablet-based software. While several job possibilities were identified, the shipping department had the greatest needs because the shipping position was a high turnover position within this company and because of the large numbers of such jobs that are commonly available across industries. Within the shipping department, a "rental box" was selected as the shipping task for testing. The rental box shipping task was the most challenging of the shipping tasks and involved many complex steps. To assess the utility of the video modeling and prompting software on the computer tablet in a real-world competitive job, the shipping task and environment were not changed or adapted for individuals with ASD.

#### 2.2.2. Job training modeling video

After interviews with key employees, a task analysis of the job was completed, which resulted in a list of 104 possible task steps that needed to be completed for error-free shipping of product. The packing and shipping process entailed: (a) organizing all materials to be shipped, (b) checking or testing each individual item to ensure it is in working order, (c) replacing faulty equipment, (d) placing all materials in a shipping container, (e) entering shipping data into a computer, and (f) printing and attaching a shipping label to the container. Each part of the shipping process included completion of multiple and complex task steps involving use of measurement devices, computer skills, manual dexterity, and decision-making. For example, process "b" described above included, among other tasks, (a) identifying how many and which type of batteries (10.5 ampHr or 18.0 ampHr) needed to be shipped based on the packing slip, (b) using a Midtronics 6/12-volt Battery Conductance Tester to test each battery to see if it had the proper charge (13.0 Volts or higher), (c) selecting, testing, and retesting a new battery if the original battery was defective, and (d) packing batteries in foam inside the shipping container.

Researchers intentionally placed “bad equipment,” such as low-voltage batteries and items with missing components, within the available equipment from which participants filled the order so as to contrive a variety of scenarios that could occur on the job site. A standard form Packing Slip, generated from QuickBooks® (a widely used small-business accounting software) identified items to be shipped and a “Ship To” address. Participants entered information from the Packing Slip into a computer running UPS WorldShip® software to generate an address label.

A performance criterion of 100% was selected for the rental box shipping task because that is the expected level of performance by the employer. This criterion level is nearly universal for all shipping tasks, as customers receiving less than complete and accurate shipments would be dissatisfied.

After completing the task analysis, a 13 min 10 s video was produced that depicted job responsibilities for the shipping tasks. Video production involved creation of a script, filming and editing of shipping tasks, and recording voice-over to guide users with the task. The shipping task video was edited into 36 segments, or “chapters,” so that users could view chunks of sub-tasks that contained manageable amounts of information.

*2.2.3. VideoTote software*

The video was loaded in proprietary software, named *VideoTote*, that was developed using an Android platform and made available on the Samsung Galaxy Tab®, a computer tablet device weighing 0.38 kilograms with a 17.78 cm picture display. The *VideoTote* software was developed as part of a Small Business Innovation Research grant funded by the U.S. Department of Education, National Institute on Disability and Rehabilitation Research. *VideoTote* software allowed study participants to use the tablet at home as a training device to review the modeling video between *Baseline* and *Intervention* conditions, and on-the-job as a prompting device while completing the packing and shipping task.

One unique and critical aspect of the *VideoTote* software is that it was designed with universal design features in mind that have been found helpful with people with intellectual and developmental disabilities [38]. The software design team consulted with an occupational therapist, reviewed published literature, and utilized focus group results to guide software development. The goal throughout software development was to create an interface ideally suited to the target population. Design features included a “chapter” format (i.e., job tasks were divided into relevant “chapters” that grouped a small number of related task steps), navigational clarity and consistency to minimize distractions and make it easy to use the device at one’s own pace, user interface specifically designed to improve ease of use for individuals with fine motor skill challenges, and a non-linear chapter selection system allowing users to easily select and review chapter tasks at any time and return to where they left off in the overall task. For example, the *VideoTote* software allowed participants to (a) select the necessary training video based on video icons and brief narrative descriptions (Fig. 1), (b) choose the video modeling format (i.e., viewing all scenes without stopping or pausing after each video chapter; Fig. 2), and (c) stop and start video viewing by touching anywhere on the screen at any time (Fig. 3).


Fig. 1. Home page of *VideoTote* software. Note: User has the option of choosing among videos related to the targeted task.

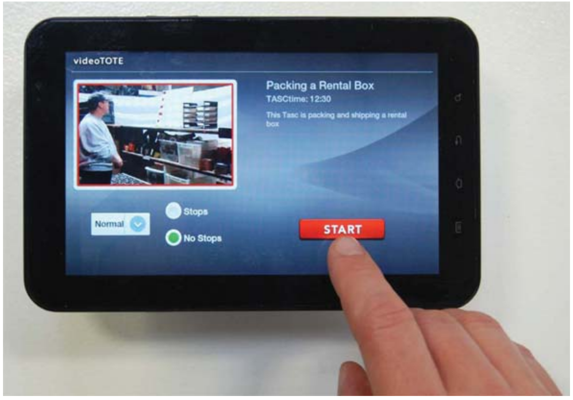


Fig. 2. *VideoTote* user interface – choice of video modeling format. Note: User has choice of watching the video from start to finish without stopping or with automated stopping of video at each chapter. A chapter represents a group of task steps that are related to each other.


Fig. 3. Viewing training video with *VideoTote* software. Note: Touching screen at any location allows user to start or pause the video. Additionally, user can perform similar functions plus forwarding to next video chapter or returning to prior video chapter by using red icon buttons at bottom of screen.

Additionally, a simple feedback mechanism was incorporated into the *VideoTote* program. Between each trial, researchers were able to substitute alternative chapters into the task video where subjects had made an error during the prior trial. In these alternative chapters, a graphic "CAUTION" appeared on a red screen and a narrator said: "Earlier, this next task wasn't done quite right. Watch the video carefully and perform the task just like the employee on the video." Regular chapter footage then resumed.

### 2.3. Target behaviors and data collection

Participants were asked to complete a shipping task (described in *Section 2.2.2.*) that involved an average of 73 steps (range = 65 to 104, depending on the shipping invoice, condition of products, and decisions made by participants during the packing process). A different shipping invoice (i.e., same types of product but with different product quantities and conditions) was used for each trial. During each *Baseline* and *Intervention* trial, an observer scored each shipping task step as completed, not completed, or not relevant (e.g., if a battery had the proper charge and did not need to be replaced, the steps involving the subsequent selecting and checking of a new battery were not relevant). The percentage of task steps completed correctly was calculated by dividing the number of relevant completed steps by the sum of relevant completed and relevant not completed steps and multiplying by 100.

### 2.4. Design

A multiple baseline across subjects design was used [22]. Multiple baseline designs are a type of interrupted time series designs that have very strong internal validity and permit investigators to show whether or not there are clear functional relationships between the presentation of an independent variable and any observed changes in behavior. After varying amounts of time in *Baseline*, the *VideoTote* software was introduced to each participant. The participant used the tablet-based software to watch the training video at home and returned to the manufacturing facility five to seven days later for the *Intervention* condition.

### 2.5. Procedure

Approval for the study was received from a university Institutional Review Board (IRB). As required by the IRB, participants' parents signed consent forms indicating their willingness to have their son participate in the study and participants were asked for their assent after being informed of the purpose and procedures of the study.

#### 2.5.1. Preparation

During the *Preparation* condition (prior to the *Baseline* condition), each participant was exposed to a typical on-site training program involving behavioral skills training. The first author demonstrated for each individual how to do each step of the shipping task from start to finish. Then, participants were instructed to try the task themselves. Participants received feedback (i.e., praise for steps completed accurately; corrective feedback and retraining for errors) as they completed each step. During training, the participants were free to ask questions and receive answers, similar to what a typical employee would experience during employee orientation. This instruction, practice, and feedback lasted approximately 45 minutes for each participant. An independent observer was present to ensure that all shipping task steps were trained accurately. If a step was omitted, the observer informed the trainer of the omission and the trainer reviewed the omitted information with the participant. Observer checklists indicated 100% fidelity to training protocol during the *Preparation* condition.

#### 2.5.2. Baseline

After completion of the standard employee training, *Baseline* was initiated during which each participant was told that he would have to complete the shipping task by himself and, "Do the best you can to complete the shipping task as you were told during the employee training." If participants asked questions during *Baseline,* they were told, "Do the best you can" and were not provided with any information about how to complete the job task.

#### 2.5.3. Intervention

After *Baseline*, participants completed a brief (i.e., 2 min) training where they were shown how to independently turn the computer tablet device on and off, charge the tablet's battery, and use the *VideoTote* software's self-paced features to access the shipping task modeling video. They were told to take the computer tablet device home, use the *VideoTote* software to view the shipping task video as much as possible during the upcoming week, document on their home log time spent watching the shipping video, and record any problems that occurred while using the *VideoTote* software as a video modeling device.

Between five and seven days later, participants returned to the job site with the computer tablet for the *Intervention* condition. During *Intervention*, participants were told to use the *VideoTote* software while performing the shipping task and, consistent with *Baseline* instructions, "Do the best you can." If participants asked questions during *Intervention,* they were, once again, told, "Do the best you can" and were not provided with any information about how to complete the job task. Participants were told to use the segmented version of the training video during the *Intervention* condition; that is, participants watched a chapter of the shipping task video, and then completed the shipping task steps demonstrated on the video. Researchers recorded whether shipping task steps were completed correctly or incorrectly during *Baseline* and *Intervention* conditions.

To access the video prompting on the job, participants attached the tablet device at eye level using Velcro® to a shelving unit above the conveyor line so that they could watch the video prompts without having to hold the device. After selecting and testing shipping contents and packing the shipping container, participants removed the tablet from the shelving unit, placed it in the shipping container, and slid both to the end of the conveyor line where they reattached the tablet to the shelving unit, weighed the container, and prepared and attached the shipping label.

### 2.6. Interobserver agreement

During 68% of *Baseline* and *Intervention* sessions, a second, independent observer simultaneously recorded the occurrence and nonoccurrence of participants' completion of shipping task steps. Interobserver agreement was calculated using the point-by-point agreement ratio method [21], which determines the percent agreement by dividing the number of agreements by agreements plus disagreements and multiplying by 100. Mean interobserver agreement was 96% (range, 91 to 100%).

### 2.7. Measures

#### 2.7.1. Task steps completed correctly

The primary dependent measure was the percent of shipping task steps completed to criterion. The employer had indicated that no errors were acceptable due to the nature of this job; therefore, 100% completion of shipping task steps was the criterion for job success.

#### 2.7.2. Home logs

Between *Baseline* and *Intervention* conditions, participants completed home logs to track the amount of time that they viewed the shipping task modeling video during the home training phase of the *Intervention*. Home log forms included space for the participant to write the day, date, start and end times, and to indicate whether a problem occurred, and if it did, what type of problem occurred.

#### 2.7.3. Universal design features

Technology that is designed with universal design features in mind tends to provide greater benefit to individuals with developmental disabilities than those developed in absence of such features [38]. To assess whether the *VideoTote* software successfully incorporated universal design features, participants and their parents were asked to complete the *Universal Design Performance Measure for Productivity* [UDPMP; 13], a 29-item checklist used to assess how well products adhere to the seven principles of universal design. The UDPMP is scored on a 5-point scale (1 = strongly disagree; 5 = strongly agree). Higher scores indicate that the product provides greater adherence to universal design features.

#### 2.7.4. Social validity

Participants and their parents were asked to complete a 7-item adaptation of the *Treatment Evaluation*

*Inventory-Short Form*, [TEI-SF; 23], a simplified version of Kazdin's *Treatment Evaluation Inventory* [20], to assess participant and parent judgments of *VideoTote* acceptability. The TEI-SF is scored on a 5-point scale (1 = strongly disagree; 5 = strongly agree). Higher scores indicate greater acceptance of the *VideoTote* software as a training and support device.

*2.7.5. VideoTote event logging*

The *VideoTote* software included event-logging capabilities that recorded occurrence and times of specific user actions on the device. For each of several types of events the *VideoTote* created a log entry with a timestamp. A small codebase (approximately 600 lines of Java code) was generated for parsing and analyzing both *VideoTote* event logs as well as score sheets for each trial. This codebase was utilized for the data analyses described below.

*2.7.6. Mining user characteristics*

In the first data analysis, use patterns were analyzed to determine whether different individuals utilized the device in predictably different ways (e.g., by tending to utilize specific capabilities of the device or rewinding chapters more frequently). These use patterns were then correlated with performance on the task during the *Intervention* condition.

For each session of *VideoTote* use, a *profile* was constructed – a vector of numbers including interface variables.[1] Session profiles were then clustered with the goal of automatically clustering together sessions from the same user, based on the profile. Home use of the *VideoTote* was clustered separately from trial performance in these experiments.[2]

## 3. Results

### 3.1. Task completion

Visual inspection of the data indicates that none of the participants consistently performed to criterion during *Baseline*, after standard employee training. The first three participants, Zeke, Tom and Ric, had stable or decreasing baselines while Dan had an initially increasing baseline that stabilized below criterion. Once the VideoTote was introduced, all four participants showed immediate improvements in performance (Fig. 4).

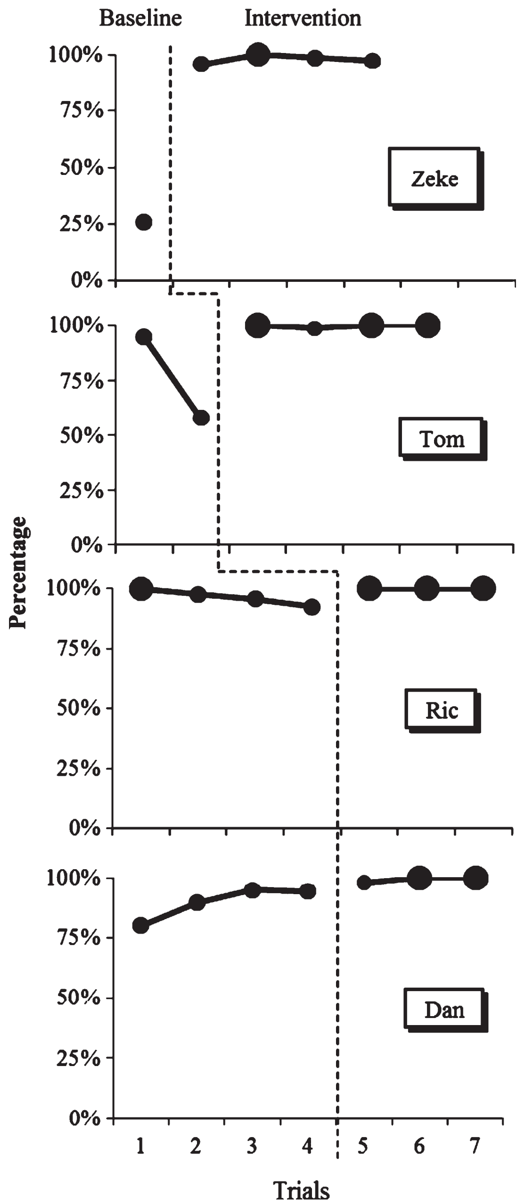


Fig. 4. Percentage of shipping tasks completed to criterion across participants. Note: Larger data point indicates criterion level performance (i.e., participant completed 100% of task steps).

Zeke provided the greatest contrast between *Baseline* and *Intervention* conditions. During *Baseline*, after traditional training and coaching, Zeke was unable to complete more than 26% of the shipping task to

[1]The users in this study included Ric, Zeke, and Tom, and not Dan due to a logging error on the latter's device.

[2]We used a simple greedy agglomerative clustering algorithm and computed similarity between sessions as the normalized dot product of the profiles minus the difference in the total number of events, normalized by the average number of events. We also discarded two sessions with fewer than 20 total events from the analysis.

criterion. When the video modeling and prompting was introduced, Zeke's performance levels increased to 92, 100, 99, and 98%. While these results indicate a marked improvement for Zeke, all but one of these was below the 100% criterion level for the task. When the "CAUTION" feedback for steps done incorrectly was provided, Zeke completed that step to criterion but missed a different task step during the trial suggesting that video prompts with fewer task steps per chapter might help him successfully complete a lengthy chain of job tasks.

Tom's performance during the *Baseline* condition deteriorated substantially during his second trial. His rate of task completion increased from 58% during *Baseline* to 100, 99, 100, and 100% during his four trials with video modeling and prompting.

There was a slight but noteworthy declining trend in Ric's performance after each *Baseline* trial. After introducing video modeling and prompting, Ric completed three consecutive shipping jobs at the 100% criterion level.

After the initial standard training for the shipping department (*Baseline*), Dan made errors but appeared to be learning or remembering more information about the shipping job with each trial. However, he repeated the same mistakes on the last two trials and did not appear to be progressing as he had previously. When video modeling and prompting were introduced, Dan completed all but one step of the process accurately. When provided with the CAUTION feedback, Dan completed the next two shipping jobs to the 100% criterion level.

All participants performed with fewer mistakes when using the *VideoTote*-based video modeling and prompting than after initial training during *Baseline* condition. All four young adults reached the 100% task accuracy criterion during the *Intervention* condition, and three maintained that level for two or more consecutive trials. On average, 68% of task steps were completed accurately during the final *Baseline* trial (after typical employee training), while 99% of task steps were completed to criterion during the final *Intervention* trial (after using the *VideoTote* software during training and on-the-job support).

### *3.2. Home logs*

On average, between *Baseline* and *Intervention* participants watched the modeling video on 6 occasions (roughly, once per day) for an average of 16 min ($SD = 2.87$) per occasion for a total of slightly more than an average of 1.5 hours (96 min) of training.

### *3.3. Universal design features*

Three parents and three participants completed the Universal Design Survey [13] after watching their son use and using, respectively, the *VideoTote* software at home as a training tool and on the job as a support device. Parents' responses indicated a high level of adherence to universal design features as indicated by an overall mean score of 4.35 ($SD = 0.34$) on a 5-point scale (Table 1). The universal design principles receiving a mean rating of 4.0 or greater were (1) Equitable Use, (2) Flexibility in Use, (3) Simple and Intuitive Use, (5) Tolerance for Error, (6) Low Physical Effort, and (7) Size and Space for Approach and Use.

Principle 4, Perceptible Information, was the only universal design principle that received a mean rating below 4.0 ($Mean = 3.98$, $SD = 0.55$). This principle addresses issues related to use of other assistive devices with the *VideoTote* software by individuals with visual or hearing impairments. Most parents rated items in this area as "Not Important" (i.e., not factored into the mean score) or "Neutral" (i.e., a "3") and commented that their son did not use any additional aids or devices.

Parent and participant ratings and comments suggested that they saw the *VideoTote*-based modeling and prompting as a viable intervention. Comments included:

- "[The *VideoTote*] has excellent potential to aid folks with disabilities." – Parent
- "Appears to be very easy for my son to follow along with. The only thing that would slow him down would be if he had a question (he usually has a lot!). If he follows along, that should help to eliminate that and help him work quicker and more effectively." – Parent
- "This was a great device to use for my son, not too big, not too small - size was great, was easy for him to manage." – Parent
- "People who aren't used to using fancy technology might not know how to use it, but people who know how to use other electronics like iPods and iPads can figure it out easy." – Participant

### *3.4. Social validity*

Three participants and their parents completed the adapted *Treatment Evaluation Inventory-Short Form* [23]. Total scores on the adapted TEI-SF can range from 7 to 35, with higher scores indicating greater

Table 1
Universal Design Survey: Parent and participant ratings and comments about *VideoTote* ($n = 6$)

| **PRINCIPLE 1. Equitable Use** | | Mean[a] | SD |
|---|---|---|---|
| 1A | This product is as usable for my son (me) as it is for anyone else | 4.00 | 1.26 |
| 1B | Using this product doesn't make my son (me) feel segregated or stigmatized | 4.67 | 0.52 |
| 1C | This product gives my son (me) needed privacy, security, and safety | 4.33 | 0.82 |
| 1D | The design of this product appeals to my son (me) | 4.67 | 0.52 |
| | Principle 1 Mean and SD | 4.42 | 0.32 |
| **PRINCIPLE 2. Flexibility in Use** | | | |
| 2A | My son (I) can use this product in whatever way is effective for me | 4.67 | 0.52 |
| 2B | My son (I) can use this product with either my right or left side (hand or foot) alone | 4.00 | 0.63 |
| 2C | My son (I) can use this product precisely and accurately | 4.50 | 0.55 |
| 2D | My son (I) can use this product at whatever pace he wants (quickly or slowly) | 4.33 | 0.52 |
| | Principle 2 Mean and SD | 4.38 | 0.28 |
| **PRINCIPLE 3. Simple and Intuitive Use** | | | |
| 3A | This product is as simple and straightforward as it can be | 4.67 | 0.52 |
| 3B | This product works just like my son (I) expects (expect) it to work | 3.83 | 0.75 |
| 3C | My son (I) understands (understand) the language used in this product | 4.83 | 0.41 |
| 3D | The most important features of this product are the most obvious | 4.33 | 0.82 |
| 3E | This product lets my son (me) know that he (I) is (am) using it the right way | 4.50 | 0.55 |
| | Principle 3 Mean and SD | 4.43 | 0.38 |
| **PRINCIPLE 4. Perceptible Information** | | | |
| 4A | My son (I) can use this product without hearing | 3.50 | 0.58 |
| 4B | My son (I) can use this product without vision | 3.50 | 0.58 |
| 4C | My son (I) can easily identify the features of this product in order to use instruction manuals or telephone help lines | 4.50 | 0.55 |
| 4D | My son (I) can use this product with the aids, devices, or techniques that he (I) uses (use) | 4.40 | 0.89 |
| | Principle 4 Mean and SD | 3.98 | 0.55 |
| **PRINCIPLE 5. Tolerance for Error** | | | |
| 5A | The product features my son (I) uses (use) most are the easiest to reach | 3.80 | 1.10 |
| 5B | This product protects my son (me) from potential hazards | 4.00 | 0.00 |
| 5C | If my son (I) makes (make) a mistake, it won't cause damage or hurt him | 4.67 | 0.52 |
| 5D | This product forces my son (me) to pay attention during critical tasks | 4.83 | 0.41 |
| | Principle 5 Mean and SD | 4.33 | 0.50 |
| **PRINCIPLE 6. Low Physical Effort** | | | |
| 6A | My son (I) can use this product comfortably – without awkward movements or uncomfortable postures | 4.67 | 0.52 |
| 6B | My son (I) can use this product without overexerting himself | 4.50 | 0.55 |
| 6C | My son (I) can use this product without having to repeat any motion enough to cause fatigue or pain | 4.33 | 0.82 |
| 6D | My son (I) doesn't (don't) have to rest after using this product | 4.33 | 0.52 |
| | Principle 6 Mean and SD | 4.46 | 0.16 |
| **PRINCIPLE 7. Size and Space for Approach and Use** | | | |
| 7A | It's easy for my son (me) to see all the important elements of this product from any position (such as standing or seated) | 4.67 | 0.52 |
| 7B | It's easy for my son (me) to reach all the important elements of this product from any position (such as standing or seated) | 4.67 | 0.52 |
| 7C | This product fits my son (my) hand size | 4.17 | 0.75 |
| 7D | There is enough space for my son (me) to use this product with the devices or assistance that he needs | 4.40 | 0.55 |
| | Principle 7 Mean and SD | 4.48 | 0.24 |
| Overall Mean and SD | | 4.35 | 0.34 |

[a]Items are scored on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree).

acceptance of treatment. In the current study, the mean total score on the TEI-SF was 34.17, providing strong support for use of the *VideoTote* software for video modeling and prompting in the workplace. Individual item means indicated that parents and participants found the *VideoTote* software to be effective, easy to

Table 2
Parent and participant ratings on the Treatment Evaluation Inventory ($n = 6$)

| Item | Mean[a] | *SD* |
|---|---|---|
| 1. I found the *VideoTote* to be an acceptable way of providing job training and support | 4.83 | 0.41 |
| 2. I would recommend the *VideoTote* to other individuals with autism who wanted job training and support | 4.83 | 0.41 |
| 3. I liked the *VideoTote* | 4.83 | 0.41 |
| 4. I believe that the *VideoTote* was effective | 5.00 | 0.00 |
| 5. I believe that the *VideoTote* was easy to use | 4.67 | 0.52 |
| 6. I believe that the *VideoTote* will help people with autism find and keep jobs | 5.00 | 0.00 |
| 7. Overall, I had a positive reaction to the *VideoTote* | 5.00 | 0.00 |
| Overall Mean and SD | 4.88 | 0.13 |

[a]Items are scored on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree).

use, and helpful to people with autism on their jobs. All indicated that they would recommend the *VideoTote* software to individuals with autism who want job training and support (Table 2).

### 3.5. Data mining

Due to the small number of participants involved in the data mining analysis, caution must be exercised against generalizing results beyond the current participants. However, data mining analyses suggest that different users utilized the device in predictably different ways. Sessions by the same user could be clustered together with reasonable accuracy. Qualitatively, the same user's sessions are likely to appear in the same cluster, although for home use Ric's and Tom's activity was similar enough that they were often clustered together. To quantify the performance of the clustering algorithm, the "B-cubed" F-measure was used, a standard metric for cluster evaluations [4]. Home use clustering exhibited a B-cubed F1 score of 0.66, significantly better than the value of a random clustering (0.45) or of clustering all events together (0.51).[3] For trial use of the device, clustering also achieved a B-cubed F1 score of 0.66, again substantially better than that of a random or all-in-one clustering (each at 0.51).

While clustering results suggest that individual users exhibit characteristic use of the device, an important question is whether these usage differences correlate with performance on the task. Results suggest that users who were effective on the job task utilized the device similarly during training at home. Tom and Ric both performed similarly on home use (the majority of Ric's sessions and all of Tom's sessions are clustered together), and they both performed similarly well on the task – Ric had no errors in three trials, and Tom had only one. On the other hand, Zeke, who exhibited a different home use profile, performed less well, making a total of seven errors across four trials. Of course, these initial findings need to be corroborated with a larger data set.

[3]The F-measure of 0.66 is significantly better than random ($p < 0.01$, Monte Carlo simulation).

## 4. Discussion

Results from this study suggest that the combination of video modeling during pre-employment training and on-the-job video prompting was helpful for individuals with autism when completing a complex shipping task. Participants and their parents gave the video modeling and prompting process and *VideoTote* software high ratings as an intervention for adults with autism to use in the workplace and as an intervention that incorporates universal design features. These results are particularly encouraging given the complexity of the targeted job task which included a high, but realistic criterion performance level in a competitive employment setting, using a variety of electronic devices to test products prior to packing and shipping, making decisions based on test results, determining what to do with defective materials, and using common commercial business accounting and shipping software in the completion of the targeted task.

The modeling and prompting resulted in marked improvement in on-the-job performance, but one participant (Zeke), was not able to produce consistent criterion level performance. Although this can be discounted somewhat because the shipping task was considerably more complex than a good number of entry-level shipping jobs and because the criterion was set higher (i.e., 100%) than typical for many non-shipping entry level jobs, Zeke continued to make different errors, albeit minor, on each subsequent trial. These results suggest that for some individuals with autism, job coaches likely will remain necessary. This should not be surprising, given the wide range of sometimes unexpected workplace demands to which one must be able to respond. Modeling and prompting devices may be able to anticipate some of those demands, but not all. In addition, the current device focused on task completion and not related skills such as coping with distractions (such as an array of colorful, unrelated labels in the shipping area). Future iterations may be enhanced by anticipating some of these indirect sources of influence as well as by providing more support or direction on the job, e.g., presenting only one task step per video chapter [11, 12]; or grouping task steps to create smaller or larger video chapters, depending on individual needs [30].

The current study provides preliminary evidence that use of the tablet-based *VideoTote* software was an effective video modeling and prompting intervention for individuals with ASD in competitive employment. When compared with recent studies that assessed the effects of technology on the job performance of individuals with disabilities [9, 16, 33], the current study involved tasks with a greater number of steps and greater complexity of job tasks. Participants in the current study completed task steps that were up to 65% greater than in the Burke et al. [9] study, between 5 and 9 times greater than in the Davies et al. [16] study, and between 40% and 78% greater than in the Van Laarhoven et al. [33] study. Additionally, in the current study, the complex shipping task required participants to successfully use digital testing devices, read outputs, and make decisions based on test results, in addition to selecting the correct materials and readying a shipping container for delivery. Based on the number and type of tasks steps and technical aspects of the job, the shipping task performed in the current study appears to be more complex than solely packing materials in a box [16] and cleaning bathrooms, floors, and kennels [33]. Also, in contrast with these studies [9, 16, 33], during the current study there was no job coach present nor did the attending researchers provide feedback or support for the participant while on the job.

Despite its effectiveness, getting video modeling into the competitive workplace has its challenges. Video playback devices often involve a user interface that takes time to learn, resulting in additional cost for the employer or more time on the job site for job coaches. For example, in Van Laarhoven et al.'s study [33], the participant required assistance in using the device during the first five instructional sessions before he was able to use it independently. In the current study, the *VideoTote* software interface was designed so that a variety of individuals with intellectual disabilities and difficulty with fine motor skills could use the device easily and intuitively. Participants using the *VideoTote* software received 2 min of instruction in how to turn the tablet on and off, and how to access and use the software. They received no additional instruction or prompting in how to use the software prior to or while completing the shipping task. Participants (including one young man with a substantial visual impairment and two others with fine motor skill impairments) reported that the software and tablet were easy to use when independently viewing the modeling video at home and as a video prompting device on the job.

The production of video modeling and video prompting can be challenging, time-consuming, costly, and not easily accomplished by individuals with few technical skills. For example, Mechling et al. [24] described using three devices to produce, edit, and deliver video, audio, and picture prompts. Cost of the three devices is estimated at approximately US$1,300.00. Due to advances in technology and subsequent reductions in cost, Samsung's 16 GB Galaxy Tab™ 7.0 Plus (an updated version of the tablet used in the present study) currently sells for US$349.99. Similar to many computer tablets in the marketplace, the Galaxy Tab has a built in video camera that can be used to film modeling videos. The video can be viewed using tablet-based *VideoTote* software without editing or downloaded to a computer for editing and uploaded to the *VideoTote* software on the Galaxy Tab for viewing.

Nevertheless, the labor intensive nature of producing video models and audio prompting segments likely inhibits its use in many settings, but especially in those competitive employment environments where efficiencies of costs and time are critical to the business' bottom line. In most cases, it is researchers, not employers, job coaches, or parents who produce video models for young adults with autism [7]. With continued advances in technology, the production and use of video modeling and prompting should be a more viable option for those working directly with adults with autism in the workplace.

An interesting technological advance that currently is available with tablet devices is data mining. Data mining and analysis were ancillary aspects of this study. Although much more research in this vein is necessary to corroborate and expand these early findings, preliminary results of data mining from *VideoTote* event logging were encouraging and suggested that user data during training may be related to on-the-job performance. This may ultimately have broad implications, potentially leading to predictive capabilities as to whom will perform well at a certain job and which types of jobs might be best suited to a specific individual. Nevertheless, event logging and data mining, while promising, involved only three participants in the current study. Data from more participants and across multiple job tasks are necessary to assess whether user data during training reliably predicts job performance.

Additional testing will help determine if initial benefits of using the *VideoTote* software to access video modeling and prompting persist over time and across job tasks. In the present study, *Intervention* conditions involved repeated trials of the shipping task but did not represent an entire day or multiple days on the job. Future studies also are needed to assess the long-term implications of using the software on the job (e.g., Does it speed up or slow down the shipping process if the video prompting is used on a daily basis?).

## 5. Conclusions

Given the dismal employment outlook for individuals with autism and the rapidly increasing number of young adults with autism entering the VR system [14], it is important to pursue vocational strategies that build on individual strengths, change the employment context, and provide individualized supports [37]. The use of tablet-based technology that can be adapted to individual and workplace needs takes us closer to realizing those pursuits. Additionally, there is clearly a need for strategies that are both effective and practical – and that address realities of the workplace. Strategies that are effective under the careful guidance of researchers but not easily accessible to individuals in “real world” jobs stand little chance of making a substantial impact in the lives of those with autism. While work with larger numbers of individuals with autism and across a variety of job tasks awaits, preliminary evidence suggests that the *VideoTote* software, and portability of tablet-based video modeling and prompting, in particular, holds promise for improving job prospects for young adults with autism currently hoping to enter the workforce.

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