J Autism Dev Disord (2016) 46:1196–1209
DOI 10.1007/s10803-015-2654-8

ORIGINAL PAPER

Initiation and Generalization of Self-Instructional Skills in Adolescents with Autism and Intellectual Disability

Katherine A. Smith[1] · Kevin A. Ayres[1] · Jennifer Alexander[1] · Jennifer R. Ledford[2] · Collin Shepley[1,3] · Sally B. Shepley[1,3]

Published online: 16 November 2015

Abstract Self-instruction using videos or other supports on a mobile device is a pivotal skill and can increase independence for individuals with disabilities by decreasing a need for adult supports. This study evaluated the effects of progressive time delay (PTD) to teach four adolescents with autism and intellectual disability how to initiate self-instruction in the presence of a task direction for an untrained task. Participants were screened for imitating video models prior to the study and were taught to navigate to videos on an iPhone® in history training. A multiple probe design across settings embedded in a multiple probe design across participants was used to evaluate the effects of PTD on initiation of self-instruction. All participants learned to self-instruct. Two participants generalized self-instruction to two novel settings. Two participants required instruction in two settings before generalizing to the third. Three participants generalized self-instruction in the presence of a task direction from the researcher to a task direction from their classroom teacher in all three settings. One participant generalized to a task direction presented by the classroom teacher in one setting, but not in the other two. All participants maintained self-instruction behaviors assessed 1 week after all participants met criteria in all settings. Self-instruction using videos or other supports on a mobile device is a pivotal skill and can increase independence for individuals with disabilities by decreasing a need for adult supports.

✉ Collin Shepley
collinshepley@gmail.com

Katherine A. Smith
katie.almand@gmail.com

Kevin A. Ayres
kayres@uga.edu

Jennifer Alexander
jlenzalexander@gmail.com

Jennifer R. Ledford
jennifer.ledford@vanderbilt.edu

Sally B. Shepley
sallybshepley@gmail.com

1 Department of Communications Sciences and Special Education, The University of Georgia, Athens, GA 30602, USA

2 Department of Special Education, Vanderbilt University, Nashville, TN 37203, USA

3 Present Address: Department of Early Childhood, Special Education, and Rehabilitation Counseling, The University of Kentucky, 229 Taylor Education Building, Lexington, KY 40506, USA

Keywords Video modeling · Self-instruction · Intellectual disability · Autism · Daily living skills · Vocational skills

Introduction

Given that teachers are required by the Individuals with Disabilities Education Act (2004), to implement instruction using "research-based intervention, curriculum, and practices" (p. 2787), many researchers have invested effort evaluating which practices have an evidence base for individuals with disabilities (Test et al. 2011; Wong et al. 2015). One source that catalogs evidence based practices (EBP's) related to transition planning for instructing individuals with disabilities in transition related skills (i.e., academic, safety, money, social, food preparation, and cooking skills) is The National Secondary Transition Technical Assistance Center (NSTTAC). Because individuals with disabilities spend a finite amount of time in public school, it is critical for teachers to select efficient instructional strategies and important target skills for preparing individuals to transition away from school environments. While some debate exists on whether time should be spent teaching academic skills/core curriculum or focusing solely on community and daily living skills while in school (Ayres et al. 2012), Bouck (2012) reported poor independent living and employment outcomes for individuals with moderate or severe ID regardless of the curriculum used (i.e., academic or functional).

In addition to focusing on specific skill selection and effective and efficient instructional strategies for individuals with disabilities, there is a need for researchers and practitioners to program for and frequently assess generalization of learned behaviors across novel settings, people, and materials (Stokes and Baer 1977). If changes in behavior do not occur in the presence of differing conditions and fail to maintain over time, meaningful outcomes for students are unlikely to be achieved. In reviewing the literature on video-based instruction (VBI; e.g., video modeling, video prompting), we identified 81 single-case studies using VBI as an intervention; only 10 of these studies assessed generalization both before and after introducing intervention. Many researchers using single-case design methodology do not measure generalization despite its importance. Additionally, generalization and maintenance data are not often considered when determining whether a practice is evidence-based. Many practitioners may not program for generalization, or may rely on "train and hope" methods (Stokes and Baer 1977). Therefore, rather than continuing to focus solely on EBP to teach specific skills (academic or functional), researchers must begin using instructional strategies to teach pivotal skills that will produce collateral effects in many areas (Koegel et al. 1999). Because individuals often require explicit instruction on a wide range of behaviors due to deficits across a number of areas, teaching pivotal skills that positively impact multiple untrained skills may result in more efficient learning (Koegel and Koegel 2012). For example, initiating interactions for many children with autism is a pivotal skill because it contributes to gains in other areas and skills (e.g., speech production, question asking), often without the need for direct instruction (Cooper et al. 2007; Koegel et al. 2003).

One pivotal behavior that may benefit individuals preparing for post-school transition is the ability to self-instruct when presented with an untrained task. Self-instruction has been defined as "The use of self-talk, printed instructions, or other materials that are used by the person alone rather than provided by the teacher. These instructions 'set the occasion' (i.e. are discriminative stimuli for the target behavior)" (Browder and Shapiro 1985, p. 204). Self-instruction is not limited to use by individuals with disabilities; typically developing adolescents and adults frequently use a variety of supports in the natural environment to self-instruct. Reading recipes from a cookbook, finding directions to a local restaurant on a handheld device, and watching an online video about how to change the oil in a car are all examples of self-instruction. Self-instructional materials improve individuals' capabilities to complete tasks that they would otherwise be unable to complete (Smith et al. 2015). Self-instructional materials for individuals with disabilities can reduce the need for intervention from an instructor while still providing the necessary information on how to complete multi-step tasks.

VBI has been used both as an instructor-delivered intervention and as a self-instructional tool. Researchers have found VBI to be an effective strategy and an EBP for teaching new and generalizable skills to individuals with disabilities (Ayres and Langone 2005; Bellini and Akullian 2007; Mason et al. 2012). VBI may be a valuable tool for self-instruction due to recent advances in mobile technology allowing individuals immediate access to information across environments (Mechling 2011). For example, when an instructor teaches a student a task-specific skill (e.g., making the bed) without teaching him or her to self-instruct, the student learns to complete specific behaviors needed to accomplish the skill. Alternatively, if the individual learns to use a handheld device (i.e., mobile technology) to view and imitate videos, the individual can learn to make a bed, in addition to a variety of other skills (e.g., fold clothes, vacuum, make a snack) independent of instructor intervention.

Despite the fact that greater independence from instructor supports is the terminal goal of teaching self-instruction, in all available studies teaching individuals to self-instruct or self-prompt, researcher instruction was a component present in every session of each study (Smith et al. 2015). Furthermore, in studies where a handheld device was used for self-instruction, the device was simultaneously delivered with a task direction (Cannella-Malone et al. 2013; Mechling et al. 2009; Payne et al. 2012; Taber-Doughty et al. 2013). This makes it impossible to ascertain whether or not the participant would independently use the handheld device in the presence of a novel task. Moreover, in many studies, the handheld device was powered up and set to the correct screen. Thus, researchers were unable to report whether participants could locate the correct videos in the presence of an unfamiliar task (Mechling and Savidge 2011; Taber-Doughty et al. 2013). Lastly, some researchers evaluated methods for teaching participants a task-specific skill (e.g., making popcorn), and then evaluated use of self-instruction for the same task (e.g., previously taught behaviors; Cannella-Malone et al. 2013; Payne et al. 2012). In these cases, participants were taught to self-instruct on behaviors already in their repertoires. This poses a problem since the terminal goal is for participants to self-instruct for unknown or partially known behaviors, rather than those already in their repertoire. All of these issues threaten the social validity of the established research base for teaching individuals with disabilities to self-instruct.

The purpose of the current study was to evaluate the effects of progressive time delay (PTD) on the initiation of self-instruction by individuals with ASD when they were presented with untrained tasks. PTD is an evidence-based response prompting procedure, which has been used to teach a variety of tasks to individuals with disabilities (Walker 2008; Wong et al. 2015). *Self-instruction* was defined as the participant independently (a) initiating the removal of the iPhone® from his pocket, (b) navigating to the correct video model, and (c) correctly completing more of the daily living or vocational skill than completed in previous sessions. The *initiation of self-instruction* was defined as the participant removing the iPhone® from his pocket following a task direction to complete a daily living or vocational skill. The research questions were: Will PTD result in increases in (a) participant initiation of self-instruction (accessing of the iPhone®), (b) independent and correct navigation to and viewing of the video model, (c) generalization of learned self-instruction behaviors to untrained settings, (d) generalization of learned self-instruction behaviors to novel task presenters, and (e) acquisition of untrained daily living and vocational skills?

Method

Participants

Participants were four high school students receiving special education services in a self-contained classroom for students with autism in a public school who had educational eligibilities of autism according to state guidelines. See Table 1 for information regarding psychometric assessment information for each participant. Participants met the following inclusion criteria for participation according to teacher report, file review, or direct assessment: (a) ability to attend to a task for 5 min, (b) fine motor ability to navigate an iPhone®, (c) fine motor ability to complete all required behaviors for targeted vocational and daily living skills tasks, (d) ability to imitate a video model, (e) individualized education program (IEP) goals related to acquisition of vocational and/or daily living skills, (f) adequate vision and hearing, and (g) failure to initiate the use of self-instruction on an iPhone® when presented with a direction to complete an unknown task. Participants typically required gesture or modeling prompts from adults to complete unknown tasks. Although file review indicated that some participants had engaged in challenging behaviors in previous school years, researchers did not anticipate challenging behaviors based on teacher report and review of participant records. Alex and Jeremy had previous experience playing games on both an iPhone® and iPad®, and John had experience playing games on his parents' iPhone at home. Dan did not have experience using smart devices prior to the study. No participant had previously received instruction using video modeling or PTD.

Settings and Instructional Arrangement

All sessions occurred in one of three settings in a public high school: (a) an outside courtyard, (b) the kitchen area in a daily living center, or (c) the office area in a daily living center. The courtyard was located directly outside the participants' classroom. This area included approximately 15 tables with attached benches on all sides; students were allowed to eat lunch and socialize in this area. The participants' classroom was divided into two sections separated by room dividers. One half of the classroom included tables, desks, and other materials used for academic instruction. The other half of the classroom contained the daily living center with a fully functional kitchen and an office. The area included one rectangular table with two chairs, three stoves, three sinks, a refrigerator, a microwave, and a toaster oven. History training occurred in the daily living center at the rectangular table. Participants not involved in ongoing study sessions remained in the other area of the classroom and were unable to hear or see the engaged participant. All sessions occurred in a 1:1 arrangement with one participant and the either the classroom teacher (generalization sessions only) or researcher (all other sessions). A second observer was present during some sessions to collect reliability data. During generalization sessions, the researcher was present in the area (classroom or courtyard) but stood as far as possible from the participant while maintaining an unobstructed view of the iPhone® for data collection purposes.

Materials

Self-Instructional Materials

Participants used an iPhone® 4 s to access video models. The iPhone® had 20 application icons on the home screen, including one labeled *videos* where the video models for this study were located. The icon for videos was in the top right corner of the screen and remained there throughout the study. The first author acted in each video, which was recorded by a graduate student using a Canon—EOS Rebel DSLR using point-of-view perspective (i.e., only the actor's hands/arms were in the frame). Each video lasted

Table 1 Participant information

Participant	Age	Eligibility category	IQ	Adaptive Behavior Scale	Autism Rating Scale
Jeremy	17 years 3 months	ASD; SLI	72 (WISC-IV)	69 (Vineland-II-teacher)	20[a] (CARS-teacher)
				59 (Vineland-II-parent)	39[b] (CARS-parent)
John	19 years 2 months	ASD	43 (WISC-IV)	65 (ABAS-II-teacher)	33.5[c] (CARS)
				87 (ABAS-II-parent)	
Dan	17 years 10 months	ASD; SLI	62 (WISC-IV)	44 (ABAS-II-teacher)	64[d] (GARS-teacher)
				50 (ABAS-II-parent)	
Alex	15 years 7 months	ASD; SLI	44 (SB5)	57 (Vineland-II)	111[e] (GARS-teacher)
					74[f] (GARS-parent)

ASD Autism Spectrum Disorder, *SLI* Speech Language Impairment, *WISC-IV* Wechsler Intelligence Scales for Children, 4th Edition (Wechsler 2003). *SB5* Stanford-Binet Intelligence Scales, 5th Edition (Roid 2003), *Vineland-II* Vineland Adaptive Behavior Scales, 2nd Edition (Sparrow et al. 2005), *ABAS-II* Adaptive Behavior Assessment System, 2nd Edition (Harrison and Oakland 2003), *CARS* Childhood Autism Rating Scale (Schopler et al. 1988), *GARS* Gilliam Autism Rating Scale (Gilliam 1995)

[a] Minimal-to-no symptoms of ASD, [b] severe symptoms of ASD, [c] mild-to-moderate symptoms of ASD, [d] probability of autism—unlikely, [e] probability of autism—very likely, [f] probability of autism—possibly

no more than 45 s. During editing with iMovie software, the first author paused the video for 1 s after the completion of an individual behavior to allow for audio narration (e.g., "Open lemonade packet"). The researcher instructed each participant to place the iPhone® in his pocket 3–10 min before beginning each session in an attempt to replicate typical contexts (i.e., many people carry an iPhone® in their pockets and remove it when they need information).

Daily Living and Vocational Skill Materials

During all sessions, the materials necessary to complete the target daily living or vocational tasks were present, and the participant was oriented towards the materials before the task direction was provided. Additional distractor materials like those commonly found in typical environments were present (e.g., coffee maker present on the counter near lemonade materials). Table 2 provides a list of targeted tasks and settings in which they were completed.

Response Definitions and Recording Procedures

The primary dependent measure was independent initiation of self-instruction (i.e., removing iPhone® from pocket) contingent on the researcher providing a task direction for an untrained skill. Data collection occurred for three behavior chains during screening, baseline, intervention, generalization, and maintenance sessions: (a) accessing the iPhone®, (b) navigating to the correct video, and (c) correctly engaging in the 3–6 behaviors need to complete the target task. The researcher served as primary data collector in all conditions and stood to the left of and approximately 1 m away from the participant to ensure unobstructed viewing of the iPhone® screen as the participant navigated to the correct video.

Initiation of Self-Instruction

The primary dependent measure was initiation of self-instruction by accessing the iPhone® within 5 s of the presentation of a task direction. Initiation of self-instruction occurred when the participant removed the iPhone® from his pocket within 5 s (or within allotted delay interval during PTD intervention) of a task direction. There were five possible responses recorded for the initiation component of self-instruction: (a) unprompted correct, (b) prompted correct, (c) unprompted incorrect, (d) prompted incorrect, and (e) no response. See Table 3 for definitions and the conditions in which responses may have occurred. Only unprompted correct responses counted toward criterion. During intervention conditions (i.e., PTD), instruction occurred only on the initiation of self-instruction.

Navigating to the Correct Video

After removing the iPhone® from his pocket, the participant was required to navigate to the correct video in order for self-instruction to occur. Data were collected on whether each necessary behavior was completed correctly for navigating to and playing the correct video on the iPhone® and were converted to a percentage correct. Steps for navigating were: (a) push home button, (b) slide to unlock, (c) push home button, (d) select videos application, and (e) select correct video. Participants learned to engage in these behaviors before baseline sessions during history training.

Table 2 Daily living and vocational tasks

Courtyard	Kitchen	Office
1. Set up board game	1. Prepare a potato for baking	1. Collate and staple
2. Hang up streamer	2. Put salsa in bowl	2. Address an envelope
3. Set up tablecloth	3. Make lemonade	3. Prepare a letter
4. Prepare a place setting	4. Grease a pan	4. Organize the binder
5. Put out name cards	5. Get 1 cup of water	5. File notecards
6. Set up flowers	6. Prepare soup	6. Sort paperwork
7. Set up BINGO	7. Put popcorn in microwave	7. Put staples in stapler
8. Serve drinks	8. Make chocolate milk	8. Sort office supplies
9. Prepare a gift	9. Brush zucchini with olive oil	9. Put papers in covers
10. Hang up happy birthday sign	10. Coat the chicken	10. Prepare package
	11. Clean the plate	
	12. Make pudding	
	13. Make Cereal	

Tasks included 3–6 behaviors and video models had a maximum duration of 45 s

Table 3 Response definitions

Response	Definition	Relevant conditions
Unprompted correct	Participant removes iPhone® from pocket within 5 s (or within allotted delay interval during intervention) of task direction	S, B, G, M, I
Prompted correct	Participant removes iPhone® from pocket within 5 s of verbal prompt	I
Unprompted incorrect	Participant either does not remove iPhone® from pocket within 5 s (or within allotted delay interval during intervention) of task direction	S, B, G, M, I
Prompted incorrect	Participant does not remove iPhone® from pocket within 5 s of verbal prompt	I
No response	Participant does not respond within 5 s of task direction (or within 5 s of verbal prompt)	S, B, G, M, I

S screening, *B* baseline, *G* generalization, *M* maintenance, *I* intervention

Because this skill was critical to self-instruction, the researcher monitored performance to ensure that remediation was unnecessary. Each step was scored as correct if a participant independently completed the behavior in the correct order within 50 s (i.e., 10 s to complete each of the five steps) of removing the iPhone® from a pocket.

Daily Living and Vocational Skills

Data were collected on the percentage of behaviors correctly completed for untrained tasks during screening, intervention, post-instruction generalization, and maintenance sessions (see Table 2). Data were not collected on daily living and vocational skills in pre-instruction generalization sessions and baseline because if participants did not self-instruct, they did not have an opportunity to complete these skills. Steps completed within 30 s of the completion of the video model were correct and could occur in any order unless a specific order was required for correct task completion. Data were summarized as the percentage of steps completed correctly and independently.

General Procedures

Before initiation of study procedures, the researcher spent three 1 h periods in the participants' classroom to minimize adaptation threats to internal validity. Study sessions were conducted between 12:00 and 2:00 PM, 1–2 times per day for 3–4 days per week. Sessions in the same setting conducted on the same day were separated by at least 1 h. During baseline, intervention, and maintenance sessions, the researcher provided a task direction for an untrained daily living or vocational task (see list in Table 2). The researcher randomly selected the target task for each session from skills the participant had completed with 50 % or less accuracy in a previous session (i.e., in any condition). When a student correctly completed 50 % of behaviors needed to correctly complete a task in any session in any condition, that task was removed from use for future sessions. If the researcher presented a skill and the participant did not engage in a response (e.g., the participant did not self-instruct and therefore did not engage with the task materials) or completed fewer than 50 % of the steps correctly, the researcher could present the same task during a subsequent session. See Table 4 for the order of conditions.

Task Completion Screening

The purpose of screening was to identify a variety of skills not currently in the participant's repertoire. Self-instruction was necessary only when a participant could not independently perform behaviors to correctly complete a specific task, as it would be inefficient to view a video model of a previously acquired behavior before engaging in a task. The researcher assessed participants' performance on a minimum of 30 skills (i.e., at least 10 for each setting) in the corresponding environment (e.g., make lemonade in the kitchen). The researcher provided materials necessary for completing each task along with distractor materials. The researcher provided a task direction related specifically to the skill being probed (e.g., "Address an envelope") and the participant had 30 s to interact with materials for each skill. All correct responses during the 30 s time period were recorded. After 30 s, the researcher ended the probe session and told the participant "good job" regardless of performance. Only skills in which a participant completed 50 % or less of steps correctly were included in subsequent sessions; behaviors taught to each participant varied based on screening performance.

Initiation of Self-Instruction Screening

The purpose of this screening was to ensure that a participant needed instruction to initiate a response. During initiation screening, the researcher asked each participant to complete a task that he was unable to complete during task completion screening sessions. Prior to the screening, the researcher gave the participant an iPhone® and told him to put it in his pocket and to continue with his ongoing activity. After 3–10 min, the researcher asked the participant to come to the daily living center. The purpose of waiting this length of time was to simulate situations in which the phone was already in the participant's pocket rather than to place the phone in his pocket immediately before delivering a task direction. If the participant removed the iPhone® prior to the researcher initiating the session, the researcher verbally instructed him to place it back in his pocket and the 3–10 min waiting period restarted. In the screening location, the researcher oriented the participant towards the materials and then provided the direction for task completion without mentioning the use of the iPhone® (e.g., "Make lemonade"). She then waited 5 s for the participant to initiate self-instruction. If the participant either failed to initiate completing the self-instructional response or began to interact with the materials for the targeted skill, the researcher immediately interrupted, recorded that the participant did not initiate the use of self-instruction, and ended the session. Only participants who failed to initiate self-instruction were eligible for study participation.

History Training

The purpose of this condition was to ensure that participants had necessary prerequisite skills to turn on the iPhone®, open the app containing videos, locate a specific thumbnail image when provided a verbal task direction from the researcher, and watch a corresponding video model. During history training, the following behaviors were assessed, and taught, if needed: (a) independent navigation to videos on an iPhone® and (b) matching

Table 4 Condition order

Participant	Setting												
Jeremy	K	BL	PTD	M		M		M		M		M	M
	O	BL		G		M		M		M		M	M
	C	BL		G		M		M		M		M	M
John	O	BL		BL	PTD	M		M		M		M	M
	C	BL		BL		BL	PTD	M		M		M	M
	K	BL		BL		BL		G		M		M	M
Dan	K	BL		BL		BL	PTD	M		M		M	M
	O	BL		BL		BL		G		M		M	M
	C	BL		BL		BL		G		BL		M	M
Alex	C	BL		BL		BL		BL	PTD	M		M	M
	K	BL		BL		BL		BL		BL	PTD	M	M
	O	BL		BL		BL		BL		BL		G	M

K kitchen, *O* office, *C* courtyard, *BL* baseline, *PTD* progressive time delay, *G* generalization, and *M* maintenance. If after intervention occurred in one setting, participants generalized in another setting, that condition is represented by a G verbal task directions (e.g., "Make lemonade") to pictures of corresponding video thumbnails (e.g., picture of lemonade pitcher and cup) paired with words describing the task.

To assess for proficiency at navigating to videos, the researcher provided the participant with an iPhone® and provided a task direction (e.g., "Watch a video about setting up a board game"). The researcher waited 50 s for the participant to complete the response. If he did not complete the response within 50 s, training was provided. Researchers used a system of least prompts procedure to teach navigation to video models (Smith et al. 2015). History training trials began with the researcher giving the iPhone® to the participant and providing a task direction (e.g., "Watch a video about making coffee"). If the participant engaged in the first navigation behavior (i.e., pressing the home button) within 10 s of the task direction, the researcher provided a general praise statement (e.g., "Good job") and waited 10 s for the participant to initiate the next step of the task analysis. If the participant engaged in an error or did not respond within 10 s of the task direction, the researcher provided a verbal prompt (e.g., "Push home button"). If the participant completed the step within 10 s of the verbal prompt, the researcher waited 10 s for the participant to initiate the next step in the task analysis. If the participant engaged in an error or did not respond within 10 s of the verbal prompt, a full physical prompt was used to ensure correct responding. Praise was provided to the participant for all independent responses (i.e., FR1) and once at the end of the session. After one session of 100 % correct independent responding on all steps, the researcher provided praise for every other independent response (i.e., FR2) and once at the end of the session. After one session at 100 % independent responding on a FR2 schedule of reinforcement, the researcher provided praise only at the end of the task analysis (i.e., FR5).

To assess for the ability to independently match task directions to pictures of video thumbnail images paired with words, an array of 10 thumbnail images glued to notecards with words describing the task glued next to the pictures were placed on a table. The researcher assessed receptive identification by providing a task direction (e.g., "Find making lemonade") and waiting 10 s for the participant to select the corresponding picture from an array of 10. After assessing responses for all images, researchers then conducted 0 s delay trials with a gesture prompt for unknown pictures. In the following trials, the researcher provided the task direction and waited 10 s for the participant to select the correct picture. If the participant did not respond or engaged in an error, a gesture prompt was provided to the correct picture. Training occurred for each image until the participant correctly identified each picture for two consecutive sessions. After meeting criteria for identification of images and navigating to the correct video, the participant was eligible to participate in baseline and intervention sessions.

Baseline

Baseline sessions were conducted in each of three settings for each participant. The researcher asked the participant to place the iPhone® in his pocket 3–10 min before beginning the session. To begin the session, the researcher oriented the participant towards the materials and provided a direction to complete the task (e.g., "Make lemonade"). The participant was given 5 s to initiate self-instruction by removing the iPhone® from his pocket. If the participant completed the initiation response, the participant had an opportunity (i.e., 50 s) to navigate to the correct video and complete the daily living or vocational skill. If the participant did not initiate self-instruction within 5 s of the task direction, the researcher immediately ended the session and provided general praise (e.g., "Good job working with me today"). The researcher asked the participant to follow her to the next setting and completed the same procedures there. The order of baseline sessions in each setting was randomized. After the final baseline session for a single day was conducted, the researcher asked the participant to return the phone and assisted him in returning to ongoing classroom activities.

Progressive Time Delay

Before beginning each session, the researcher provided the iPhone® using procedures described for baseline sessions. During instructional sessions, PTD was used by gradually increasing the delay interval in 1 s increments from 0 to 5 s. For 0 s delay sessions, the researcher provided a task direction for a skill (e.g., "Make lemonade"), and then immediately provided the controlling prompt (i.e., "Get your phone out and watch a video about how to make lemonade"). If the participant removed the phone within 5 s of the prompt, the researcher allowed the participant 50 s to navigate to the correct video. If the participant responded incorrectly after the verbal prompt (i.e., error or non-response within 5 s), the session was ended and the same delay interval was used for the next PTD session. If a participant responded correctly before the prompt or within 5 s of the verbal prompt, the delay interval for the next session increased by 1 s, up to a maximum of 5 s. If a participant began an incorrect response before the delay interval allowed for the delivery of the controlling prompt, the researcher used error correction by immediately providing the controlling prompt. Mastery criteria was set at three sessions (at least two consecutive) with

(a) unprompted correct initiation of self-instruction, (b) 100 % correct navigation to the correct video model, and (c) improved performance on the daily living or vocational skill by at least one step when compared to previous performance in screening, baseline, or previous intervention session.

Generalization and Maintenance

Generalization sessions were identical to baseline sessions except that the classroom teacher provided the task direction. Maintenance sessions occurred for previously mastered settings and were identical to baseline sessions. A maintenance session also occurred once at the end of the study, 1 week after all participants met criteria in all settings.

Experimental Design

A multiple probe design across settings embedded in a multiple probe design across participants (Ledford and Gast 2014) was used to evaluate the effectiveness of PTD to teach participants to self-instruct on untrained daily living and vocational skills (see Figs. 1, 2). The embedded multiple probe design across settings allowed for monitoring of generalization across settings but also allowed documentation of experimental control via time-lagged introduction of the intervention across participants in the multiple probe across participants design. Self-instruction was only necessary for a given task if the participant correctly engaged in 50 % or fewer of the steps required to complete that task. Therefore, in each session, the targeted task was one in which the participant completed 50 % or fewer of total steps during previous sessions. The order of settings in which intervention was introduced was counterbalanced across participants (see Table 4). The sequence in which participants received intervention was dictated by the participants' daily classroom schedule.

Baseline data collection occurred on initiation of self-instruction for different skills across three settings. Intervention began with the first participant in Setting 1 after establishing stable responding during baseline. No sessions occurred in Settings 2 or 3 for the first participant, or for any setting for the remaining participants, until the first participant met mastery criteria in Setting 1. Mastery criteria included independently initiating, navigating to, and viewing the correct video model as well as increasing performance on the daily living or vocational skill from previous sessions for at least three sessions (at least two consecutive). When the first participant met criteria for self-instruction in Setting 1, baseline sessions occurred for all participants in all three settings, and then intervention began for the second participant in Setting 1 while the third

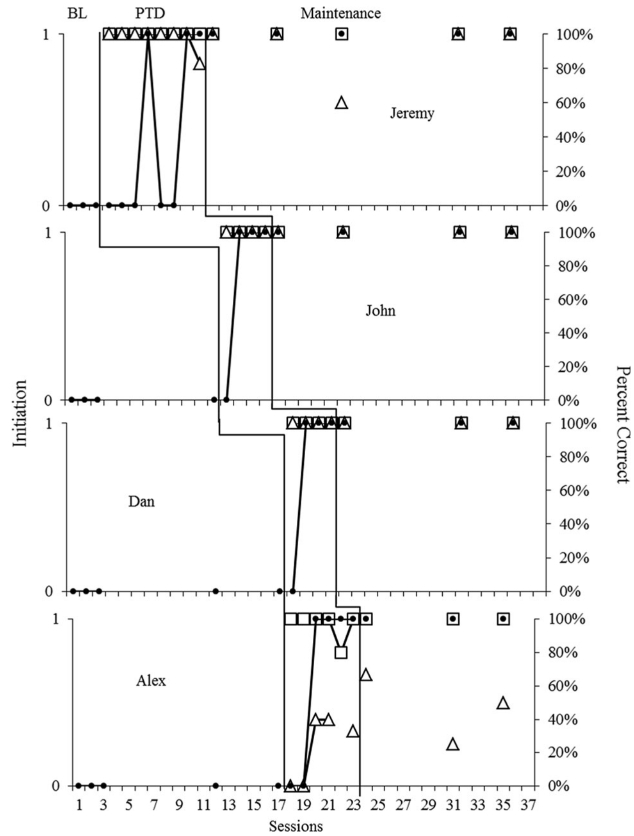

Fig. 1 Self-instruction data for all participants in Setting 1. The *closed circle* represents initiation, the *open square* represents navigation to correct video, and the *open triangle* represents percentage correct on daily living/vocational skill. *BL* baseline, *PTD* progressive time delay

and fourth participant remained in baseline. If a participant generalized the self-instructional response to a setting in which instruction did not occur (i.e., while the researcher was the instructor), instruction did not occur in that setting. If the participant generalized self-instruction to one untrained setting but not the other, intervention occurred for the setting in which generalization did not occur. If a participant did not generalize to Settings 2 and 3 after instruction in Setting 1, intervention occurred for initiation of self-instruction in Setting 2. Following mastery of self-instruction in any setting during intervention, probes were conducted in all settings to assess for maintenance of behaviors in previously trained settings and generalization of behaviors to untrained settings.

Interobserver Agreement and Procedural Fidelity

Interobserver agreement (IOA) and procedural fidelity (PF) data were collected and calculated for 32 % of baseline sessions, 28 % of intervention sessions, 30 % of maintenance sessions, and 50 % of generalization sessions for each participant. IOA was calculated separately for

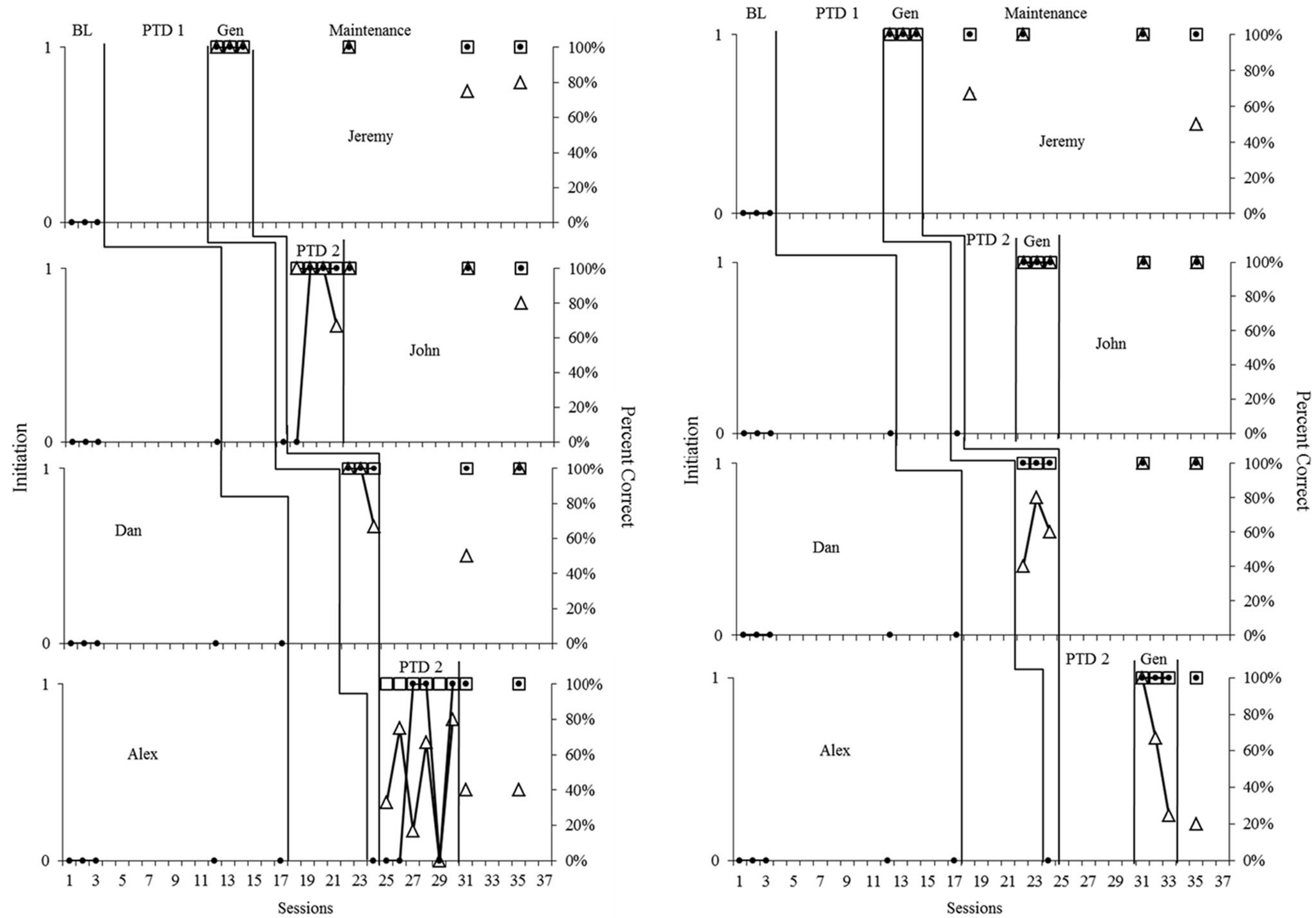

Fig. 2 Self-instruction data for all participants in Settings 2 (*left panel*) and 3 (*right panel*). The *closed circle* represents initiation, the *open square* represents navigation to correct video, and the *open triangle* represents percentage correct on daily living/vocational skill. *BL* baseline, *PTD1* progressive time delay in setting 1, *PTD2* progressive time delay in setting 2, *Gen* generalization

initiation of self-instruction, percentage of steps independently completed for navigating to the correct video, and percentage of task steps independently completed. IOA was calculated using point-by-point agreement by dividing the number of agreements and by the number of agreements plus disagreements and multiplying by 100 (Ayres and Ledford 2014). Because responses for initiation of self-instruction were recorded as yes or no, agreement was scored for that behavior as either 0 or 100 % for each session. IOA was 100 % for initiation of self-instruction, navigation to the correct video, and steps performed correctly on daily living or vocational skills.

PF data were calculated by dividing the number of correct researcher or teacher behaviors by the total number of expected researcher or teacher behaviors and multiplying by 100 (Ayres and Ledford 2014). PF data were recorded for the following behaviors in baseline, generalization, and maintenance conditions: (a) correct materials for daily living and vocational skills were available and in view of participant, (b) iPhone® was available and set up correctly (i.e., the phone was turned on, the home screen was locked, correct videos were loaded on phone), (c) iPhone® was in participant's pocket for 3–10 min prior to the session initiation, (d) correct task direction was provided, (e) no un-programmed prompting was provided, (f) participant was given 5 s to initiate self-instruction by removing the phone from his pocket, (g) participant was given 50 s to navigate to the correct video (and additional time to view the selected video), (h) participant was given 30 s to complete the vocational or daily living skill, and (i) the participant was provided with general praise at the end of the session. During intervention conditions, PF data were recorded for the previously mentioned behaviors and that the controlling prompt was provided using correct delay interval (only if participant made an error or did not response within delay interval). If the participant did not remove the phone from his pocket (i.e., step f), the session ended, and procedural fidelity steps (g) and (h) were scored as not applicable (NA). PF was 100 % in all conditions for all participants.

Results

Navigating to the Correct Video

A system of least prompts procedure was effective for teaching participants to navigate to videos on the iPhone® during history training in 7–10 sessions. During intervention, maintenance, and generalization sessions, there was only one session in which a participant initiated self-instruction (with or without prompting) and did not navigate to the correct video. After history training, no additional prompting was provided on navigating to the correct video, even for the participant who did not navigate correctly in one session.

Acquisition of Initiation of Self-Instruction

No participant independently initiated self-instruction in any setting during baseline conditions (Figs. 1, 2). After eight sessions of PTD instruction, Jeremy mastered initiation of self-instruction in Setting 1. After mastering self-instruction in Setting 1, Jeremy generalized performance to Settings 2 and 3; therefore, instruction did not occur in those settings. After one 0 s delay session, John began independently initiating self-instruction by removing the iPhone® from his pocket in the presence of a task direction to complete an untrained task. John mastered initiation of self-instruction in Setting 1 in four sessions, but did not initially generalize to Settings 2 or 3. He mastered self-instruction in four sessions in Setting 2, and generalized responding to Setting 3. Dan began to independently initiate self-instruction after one 0 s delay session and mastered self-instruction of Setting 1 in four sessions. He generalized self-instruction to Settings 2 and 3. Alex mastered self-instruction in Setting 1 in six sessions. He did not generalize the use of self-instruction to Settings 2 or 3 after intervention in Setting 1; therefore, intervention began in Setting 2. After mastering self-instruction in six sessions for Setting 2, responding generalized to Setting 3.

Generalization Across Settings

Before and after acquisition of self-instruction in Setting 1, the researcher assessed self-instruction in Settings 2 and 3; Fig. 2 depicts generalization data for these settings. Jeremy and Dan learned to self-instruct in Setting 1 and generalized that behavior to Settings 2 and 3. John and Alex required instruction on self-instruction in Settings 1 and 2 before generalizing to Setting 3. All participants met criteria in settings to which they generalized self-instruction in three sessions.

Generalization to a Familiar Adult

To evaluate the fourth research question regarding generalization across instructors, a pre-post-test paradigm was used (see Table 5). In the pre-test, no participant initiated self-instruction with the classroom teacher providing a task direction. After all participants met criteria in all settings, the classroom teacher conducted a generalization post-test. Jeremy, John, and Dan generalized self-instruction when the task direction was provided by the classroom teacher in all three settings; independently initiating self-instruction within 5 s, navigating to the correct video, and increasing performance on a target task. In Alex's first generalization post-test session in the kitchen (i.e., target setting), he did not initiate self-instruction by removing the iPhone® from his pocket and therefore did not have the opportunity to navigate to the video or attempt the daily living or vocational task. Alex's second generalization session occurred in the office. In this setting, Alex initiated self-instruction and navigated to the correct video, but did not complete any steps of the daily living or vocational skill correctly. In Alex's last generalization session, which occurred outside, he initiated self-instruction, navigated to the correct video, and improved task performance.

Acquisition of Daily Living and Vocational Skills

Self-instruction involved both initiating the self-instructional response and viewing the correct video. Additionally, for self-instruction to have both taken place and to have been effective, the participants had to increase performance on the daily living skill from previous sessions. Jeremy initiated (prompted or unprompted) and navigated to the correct video in 30 total sessions. His performance on daily living or vocational skills in these sessions was at a mean of 93 % correct responding (range 50–100 %), with 100 % correct responding during 23 sessions. He received instruction on eight skills throughout PTD sessions before generalization occurred. John had the opportunity to attempt daily living and vocational tasks in 23 sessions. His mean percentage correct on these tasks was 99 % (range 67–100 %), with 100 % correct responding during 22 sessions. He received instruction on four skills in the office setting and four skills in the outside setting prior to generalizing. Dan had the opportunity to attempt daily living and vocational tasks in 20 sessions. His mean percentage correct on these tasks was 85 % (range 33–100 %), with 100 % correct responding in 13 sessions. He received instruction on four skills before generalizing. Alex had the opportunity to engage with materials for the daily living or vocational tasks in 25 sessions. His mean percentage correct on these tasks was 41 % (range 0–100 %). Alex completed 100 % correct on only two tasks (both 3 steps in

Table 5 Generalization to a familiar adult

Participant	Setting	Initiation of self-instruction		Navigation to correct video	Daily living skill
		Pre	Post	Post (%)	Post (%)
Jeremy	Kitchen	0	1	100	100
	Office	0	1	100	80
	Courtyard	0	1	100	100
John	Office	0	1	100	100
	Courtyard	0	1	100	100
	Kitchen	0	1	100	100
Dan	Kitchen	0	1	100	100
	Office	0	1	100	40
	Courtyard	0	1	100	75
Alex	Courtyard	0	1	100	50
	Kitchen	0	0	N/A	N/A
	Office	0	1	100	0

length). He received instruction on five skills in the outside setting and five skills in the kitchen setting before generalization occurred.

Discussion

This study demonstrated the effectiveness of PTD on the initiation of self-instruction using an iPhone®. A functional relation was demonstrated in the context of a multiple probe across participants design in which the introduction of PTD was staggered across participants. Participants all learned to initiate self-instruction in three settings, with PTD instruction occurring in only one or two settings. Additionally, three of four participants generalized self-instruction to the presentation of a task direction from their classroom teacher in all three settings, while one participant met criteria in one setting in a generalization post-test. This study is an important extension of previous research in the area because participants were instructed only to complete an unknown task rather than being directed to use self-instruction materials. When participants increase use of self-instruction and video supports to acquire previously untrained skills, the need for adult support decreases, which may increase access to new environments. Additionally, when an individual self-instructs using video models rather than with support from adults, he or she may have an opportunity to learn more skills since adult instruction is not required for each skill.

One critical finding of the study relates to generalization across settings. This study occurred in the context of a multiple probe across participants and settings design so the researchers could assess generalization across settings within the context of a single case design. More studies on the generalization of behavior for individuals with developmental disability are needed, but this initial study suggests individual participant differences may have contributed to the number of settings in which instruction was required before generalization occurred. Jeremy and Dan, who generalized after instruction in only Setting 1, scored higher on IQ testing than John and Alex. Jeremy also had a more expansive vocabulary and was working on higher-level skills than other participants.

With the exception of Alex, all participants generalized self-instruction to a task direction presented by their classroom teacher in all settings. In the generalization probe for the kitchen, in which Alex did not initiate self-instruction and therefore did not have an opportunity to complete the remainder of the steps of self-instruction, his teacher stated that he was upset about a classroom issue involving his lunch. This may have contributed to a lack of responding, but more research is needed to help clarify what student and/or instructional characteristics influence generalization of behaviors across settings and instructional agents.

Participants accessed videos independently and were in control of the iPhone® resulting in differential use of the videos. John viewed the entire video before accessing materials. He then imitated the video exactly in the order that the actor completed steps. For example, in the video for collating and stapling papers, there were three numbered sheets of paper and the actor pointed to the number in the top right corner of the page to signal how to order the papers. Although pointing was not part of the task analysis, John completed this non-essential step after viewing the video. Jeremy viewed the video while completing the task in each session. As the video paused to narrate the directions for the next step, Jeremy collected the needed materials and began engaging with the materials to complete the task. Dan viewed the entire video before completing the task in early sessions, but he began to complete the tasks while watching the videos in later sessions. Alex sometimes viewed the entire video before completing the task and sometimes completed the task while watching the video. Alex is the only participant who accessed correct videos in some sessions without completing any correct steps of daily living or vocational skills. Although data on attending are unavailable, anecdotal information from Alex's sessions indicated that his eyes were often not oriented toward the iPhone for the duration of the video. These observations are important because they indicate that (a) similar participants may have different preferences regarding use of VBI, and (b) difficult-to-measure fidelity of use variables (e.g., attention) may have an impact on acquisition of target behaviors.

Limitations

The primary limitation regarding generalization across adults is that the researcher was present during generalization sessions when the classroom teacher served as the instructor. Although the classroom teacher provided the task direction, the presence of the researcher could have influenced performance. It was not possible to assess generalization in Setting 2 for Alex on self-instruction with the classroom teacher present due to the school year ending. Another limitation is that Alex completed all behaviors correctly only for the tasks that included the fewest number of steps (i.e., three) and shortest video length (i.e., 22 s). The current study did not control for number of steps and video length across videos used in the study, and screening for the ability to imitate from a video model only included a three-step task. Lastly, while the expected response was that after being exposed to intervention, each participant would self-instruct when provided a task direction for an untrained skill, it is possible that participants overgeneralized and viewed video models for already learned skills (i.e., in environments outside of the research study). While future studies should evaluate methods for teaching individuals who have acquired self-instruction of untrained skills to discriminate between when self-instruction is necessary and when a skill is already learned, the current study did not address this question. While this is a limitation, it is preferable to the inability to self-instruct when presented with unknown tasks because while it might be inefficient, it still allows for increased independence and correct performance.

Future Research and Implications for Practice

While VBI remains a heavily researched and established EBP, there is a need for established procedures to teach independence in accessing video models. Future research should focus on evaluating methods to teach participants to discriminate between known and unknown behaviors, so they can determine when to view videos before engaging in a task. Additionally, future research is needed to assess the effectiveness of teaching participants to access videos from online video libraries (e.g., iSkills, YouTube), or to create their own videos for skills specific to them (e.g., a job skill at a specific restaurant). When using online libraries or other VBI, researchers should consider participant preference and learning histories with video modeling versus video prompting. This is especially relevant for participants who may independently initiate but not complete all steps of a task correctly (e.g., Alex). With the current study, although an adult was present to provide a task direction, adult-provided instruction was not required for participants to complete the given task (i.e., no prompting was provided to participants on individual steps of daily living or vocational tasks).An adult could, essentially, create a library of videos to be loaded on several different participants' phones, and then provide a task direction to one participant to complete a skill in the kitchen, to another participant in the office, and another participant in the classroom simultaneously. Researchers and practitioners should also consider assessing the utility of self-instruction with video models across tasks at job sites. The implications of this practice can have profound effects as this means potential access to more environments and the possibility of learning an increased number of behaviors during a given time period.

Once an individual learns to self-instruct, he or she may also be able to use this skill for a previously learned behavior for which remediation is needed (e.g., when the steps required for completion have been forgotten; Bereznak et al. 2012). That is, if an individual learns to make coffee at work, but after vacation does not maintain the behaviors needed to complete the task, adult instruction would not be required because the individual could independently access the video model. A continued focus on pivotal skills for individuals with disabilities is critical for effective and efficient instruction to result in meaningful changes for each individual.

Considering the persistent and widespread use of mobile technology by nearly all adolescents and adults, the potential for self-support and self-instruction using this technology has greatly increased. Most people with a mobile device have familiarity with using Google to look up an answer to a question or get directions. Teaching individuals with disabilities these similar skills for self-support and self-instruction creates more opportunities to live independently and integrate fully into their communities. When compared with secondary instruction that focuses on instruction of a lengthy list of functional life skills (Ayres et al. 2012) or Common Core Standards

(Courtade et al. 2012), an increased focus on pivotal skills, such as problem solving and self-instruction, has the potential for increasing the number of skills individuals can learn on their own and the number and types of environments they can access without constant adult support.

Acknowledgments Financial support for this study was provided by the Institute of Education Sciences, U.S. Department of Education, through Grant R324A1000094 to the University of Georgia. The study was completed by the first author at part of her doctoral dissertation.

Author Contributions KAS contributed to the initial conceptualization of the study, the design, coordinating study sessions, running sessions, data collection, analyzing data, and drafting the manuscript. KMS contributed to the initial conceptualization of the study, the design, analyzing data, and helping draft the manuscript. JLA contributed to the initial conceptualization of the study, the design, data collection, analyzing data, and helping draft the manuscript. JRL contributed to the initial conceptualization of the study, the design, analyzing data, and helping draft the manuscript. CS contributed to helping draft and revise the manuscript. SBS contributed to the initial conceptualization and revising the manuscript.

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