



Comparing Instruction Methods for DailyBuddy: A Mobile App for Improving Daily Living Skills for Adults with Autism

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Abstract. Individuals with autism spectrum disorder (ASD) often experience challenges with performing their daily living skills which may result in their limited participation in daily activities and dependence on their family. This paper presents the development and usability of a mobile-based interface supporting adults with ASD in everyday living. The application is called “DailyBuddy” and aims to support the independent living of autistic individuals via planning daily tasks (e.g., chores, groceries, and cooking), reminding them when tasks are due, and showing them how to perform daily living tasks. This study’s primary focus is investigating the effect of three different instructional methods (video prompting, image prompting, and a checklist) on user performance and preference. A total of 23 individuals on the autism spectrum (17 male and six female participants) participated in a between-subjects study. Our findings indicated the effectiveness of the daily living application in improving the quality of performing tasks. Although participants favored the checklist method more than others regarding user preference, the statistical analysis comparing the three instructional methods showed no significant difference. This information can improve the DailyBuddy application, enhance education, and increase independence for adults with autism.

Keywords: Autism · Daily Living Skills · Mobile Technologies · Video Prompting · Image Prompting · Checklists

1 Introduction

Autism spectrum disorder (ASD) is a lifelong complex neurological condition. Individuals with ASD can experience difficulty expressing how they feel, understanding sarcasm, avoiding eye contact, social skills, limited communication abilities, problems with controlling emotions or recognizing others’ emotions, repeated activities, and a limited range of interests [35, 37]. The term spectrum

implies a wide range of symptoms associated with ASD, encompassing autistic disorder, Asperger’s syndrome, and pervasive development disorder [8]. In 2020, the ASD prevalence was reported as about 1 in 36 children in the US by the Centers for Disease Control and Prevention (CDC) [1]. This highlights the importance of research on how to help individuals with ASD.

Autism affects individuals in varying ways, including their ability to learn, communicate, memorize, interact, and process information [32]. Autistic individuals usually depend on their family members or assistance programs. This can result in decreased independence, limited participation in daily activities, and a lower quality of life and employment opportunities [21]. Therefore, it is important to provide platforms and education that teach daily living skills to autistic students before their graduation.

DailyBuddy is a mobile-based interface that aims to support autistic individuals in their daily life situations (e.g., navigating conflict at work, cooking healthy meals, and using “life hacks”) via planning daily tasks (e.g., chores, groceries, and cooking), reminding them when tasks are due, and showing them how to perform a task using videos, images, or checklists. In addition, an Augmented Reality (AR) avatar can be used to locate where chores need to be done and motivate participants. One of the primary goals of the app is to help autistic individuals increase their independence in performing their daily tasks such as chores, groceries, and cooking. For this purpose, over 30 presets of tasks with video instructions, image promptings, checklists, and reminders are provided. However, finding the best method for teaching daily living skills is challenging. In this study, we specifically focused on investigating the effect of three instructional strategies on the performance and preference of autistic learners. Video Promoting (VP), Image Prompting (IP), and checklists (CP) are three instructional methods that have been proposed as potential alternatives to traditional teaching methods [10, 36, 44]. This study aims to answer the following research questions by conducting a human-centric study on individuals with ASD:

- RQ1. Do users have a preferred instruction method among the three provided in DailyBuddy?
- RQ2. Does the type of instruction method affect user engagement?
- RQ3. How do different instruction formats influence user performance in terms of speed and accuracy?
- RQ4. Which features of the DailyBuddy app are preferred by autistic users, and which ones need improvement?

A key **motivation** for the research presented in this paper is our appreciation for the challenges that people with ASD currently face in achieving employment. While we acknowledge the spectrum is quite diverse, Dan Marino Foundation (DMF) [2] has concentrated on working with younger adults between 18 to 30 years old, where they look to provide training for different types of jobs to seek some level of independence. Most of the DMF population have another developmental disability beyond their ASD condition. The national US average employment rate reported by the U.S. Office of Disability Employment Policy [6]

for people with disabilities is 19.1% while the DMF employment placement is 72%. However, given that the foundation has only limited reach in their local community, scaling up those accomplishments is very challenging. We believe that looking at technology is critical as you try to scale and help more individuals. Hence, it is important to systematically study the use of technological support by people with ASD. The application presented here concentrates on daily tasks, which will transfer to more employment, as stated in previous findings [25].

The Research Presented Here Makes Four Primary Contributions to the State-of-the-Art. First, to our knowledge, no previous study investigated the effect of these three instructional methods together (i.e., VP, IP, and CP). Second, it introduces an application aimed at helping adults with autism that have not received enough attention compared to children with autism regarding available applications for the community. Third, it addresses challenges with the DailyBuddy application and discusses methods to improve it. Fourth, our experiment includes a relatively large number of participants compared to many existing studies on autistic individuals, offering a stronger foundation for understanding the community's needs. Finally, this work opens up new opportunities for a secondary parental app that can help achieve more accessible and supportive technology use for people with ASD. The findings of a previous study by Yakubova and Chen supported the positive effect of a parent-created and parent-implemented video promoting intervention on teaching daily living skills to adolescents with ASD [43].

2 Related Works

Technological solutions can positively impact the development and daily lives of autistic individuals. Several previous studies showed that autistic individuals prefer technology-based support over non-technological support strategies [19].

2.1 Mobile Technology for Autism

The increased number of people diagnosed with ASD led to the development of mobile applications aimed at helping the target community [40]. Mobile interfaces allow personalized learning, which can help autistic individuals learn at their own pace and in a way that works best for them. Additionally, mobile interfaces can track an individual's progress and provide data on their learning and performance. This can help caregivers and educators understand what is working and make adjustments as needed. Finally, the fact that most people already own a smartphone means that mobile applications are both more accessible for low-income users and less stigmatizing when used as accessible technologies in public [26]. Odom et al. showed in their study that autistic individuals are often comfortable and well-versed in the use of these devices [33]. However, for these applications to have the intended positive effects, it is crucial that they take into account the specific and unique needs and preferences of their users [23].

A wide range of mobile solutions has been developed to assist autistic individuals in different applications, such as education [42], communication skills [22], functional skills [39], daily living skills including shopping [21], cleaning [16], cooking [21], doing laundry [16,21], and doing morning routine [21]. The target group for evaluating most of these applications was children, and adults with ASD have not received similar attention. On top of this severe lack of studies that target adolescent and adult autistic individuals, many existing digital solutions had not been thoroughly evaluated and tested for adults or have only been tested with people outside of the respective communities they aim to assist [24], making these evaluations not generalizable for ASD individuals.

2.2 Daily Living Skills

Daily Living skills are divided into “basic” and “instrumental” by the Occupational Therapy Practice Framework [18]. Basic skills are the ones that need individuals to take care of their own bodies, such as eating, grooming, bathing, and toileting. Instrumental skills include interacting with the environment and participating in complex daily tasks such as doing laundry, washing the dishes, making the bed, and preparing meals) [18]. The results of a study by Duncan et al., aimed at understanding the concerns of parents of adolescents with ASD, confirmed the need for an intervention that would teach instrumental skills to their adolescent since the majority of adolescents with ASD had not mastered age-appropriate daily living skills [21]. Mastering instrumental skills can have a positive effect on post-secondary education, employment, and independent living of autistic individuals [25].

Several previous studies used interventions to teach daily living skills to autistic individuals, such as toilet training [31], daily routines [17], folding clothes [9], doing laundry [36], preparing a meal [9,10], washing the dishes [36], cleaning [9,44], etc. Various methods have been investigated to teach different skills to autistic individuals, such as *vivo* modeling, video instructions, picture or image prompting [36], audio promoting (AP) [36], and checklists [44]. In *vivo* modeling method, a live model performs the target behavior, and autistic people observe their actions live. Video instruction encompasses Video Modeling (VM) [9,15], Video Self-Modeling (VSM) [34], and Video Prompting (VP) [10]. VM consists of each user watching a video of models performing the target behavior. These videos may be filmed from the viewer’s perspective and only portray the arms and hands of the model performing the task [9]. VP is similar to VM; however, it allows students to watch specific steps of a task as needed, rather than the entire process [10]. In the VSM method, individuals learn how to perform a task by watching themselves engage in a task [34]. VSM involves participants in both video production and video viewing sessions. Several studies have compared different methods for teaching daily tasks to autistic individuals. In checklists, users are given explicit rules for completing a daily living task. For example, Duncan et al. gave explicit instructions on how to do laundry to adults with ASD (e.g., sorting laundry, identifying the appropriate washing machine cycle to wash clothing items, and folding shirts using a folding board). Technological solutions for

scheduling and daily tasks across different platforms have been shown to improve the understanding of time and date concepts in ASD children [42]. Table 1 shows a summary of several previous studies used various interventions to help autistic users learn instrumental tasks.

Table 1. Summary of several previous studies used different instructional methods for autistic users (VP: Video Prompting, IP: Image Prompting, CP: Checklist Promoting, VM: Video Modeling, AP: Audio Prompting, VSM: Video Self-Modeling, m: male, f: female)

Ref.	Year	Method	Task	Age	Num.
Ours	2025	VP, IP, CP	Washing the dishes, making the bed	(19-26)	17m+6f
[15]	2020	VM	Greeting, service, and closing phrases	(18-26)	5m+1f
[36]	2019	IP, AP	Washing the dishes, doing laundry	(25-37)	4m
[34]	2017	VSM	Towel folding, vacuuming, bathroom cleaning	(21)	1m
[9]	2016	VM	Make tortellini, set the table, fold jeans, clean counter and sink, clean the mirror	(15-18)	2m
[10]	2012	VP	Washing the dishes	(15-18)	3m
[44]	2012	VM, CP	Cleaning the mirror, sink and floor	(16-19)	2m+1f
[29]	2011	VP	Novel tasks, Transition between tasks	(14-15)	2m+1f
[41]	2009	VM	Cleaning the bathroom, mopping the floor, emptying garbage, cleaning kennels	(17)	1m
[28]	2009	IP, VP, AP	Three cooking recipes	(16-17)	3m
[27]	2008	VP	Three cooking recipes	(19-22)	1m+1f

3 Method

This study examined three instruction methods available in the DailyBuddy app for adults with autism (see Fig. 1), focusing on user preferences (RQ1), engagement (RQ2), performance (RQ3), and challenges faced. Semi-structured interviews were conducted to better understand users’ feedback and needs (RQ4). This study is approved by Colorado State University Institutional Review Board prior to data collection and recruitment.

This experiment is a 3-factorial between-subject design. The independent variable is the instruction method used to teach the daily living task: VP, IP, and CP (see Fig. 1c). The VP method uses video clips to demonstrate each step of the task. Students who struggle with abstract concepts can benefit from visual learning. Videos include subtitles and audio. After each step is shown, the video pauses and requires users to select the next step. Users need to press the play button again to watch the video of the next step. Users were allowed to watch the whole video at the beginning and then complete the corresponding steps or watch the video of each step and then complete that step. The IP method uses pictures to show a sequence of steps for completing a task. The pictures are arranged in a logical order, and the student is shown each picture in sequence

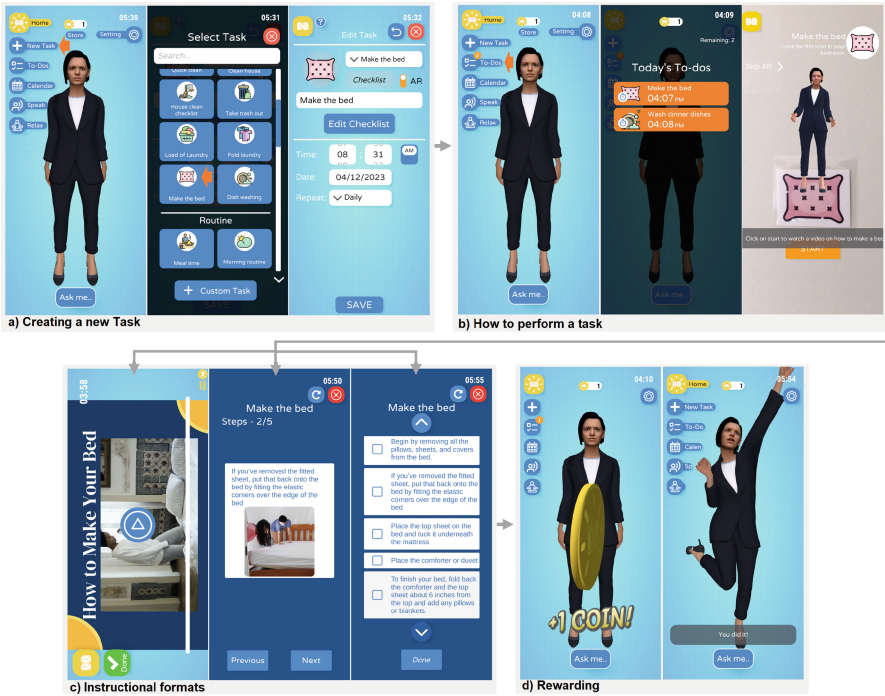


Fig. 1. Experiment procedure a) Creating a new task b) and c) How to perform a task c) independent variables: 1. video instructions 2. image promptings 3. Checklist D) Rewarding 11. coin rewards 2. happy animation and encouragement statement.

as they complete each step of the task. A text explaining that step accompanies the image to help better understand the step. The app shows a picture of one step at a time. The third condition is a checklist which is a written list of steps required to complete a task. The checklist is organized in a logical order, and the student can use it as a guide to ensure they complete each step of the task. This can be a helpful strategy for students who are able to read and may benefit from seeing the steps written out clearly and concisely together.

ASD individuals can be classified into three groups, based on the level of assistance required. The severity of ASD symptoms ranges from mild to severe, with individuals at Support Level 3 (SL3) experiencing the most severe symptoms, while those at Support Level 1 (SL1) exhibit symptoms on the milder end of the spectrum. SL1 ASD denotes the least severe form of autism, characterized by difficulty in appropriate communication with others. In comparison, individuals diagnosed with Support Level 2 (SL2) typically exhibit more pronounced issues with verbal and social communication than those at SL1. They may also face difficulties in changing focus or transitioning from one activity to another. Finally, those with level 3 autism have a limited capacity for clear speech [3, 7].

To minimize biases, participants were distributed across the three experimental conditions based on their support level and gender. The level of support each student needed was reported by the education director of the DMF, who has experience working with these students for around eight years. Two other experimenters have the experience of working with autistic individuals for more than two years in terms of teaching and developing applications for autistic students.

3.1 Equipment

The DailyBuddy application was installed on three iPads to deliver three instructional methods. Each iPad had a resolution of 2048×1536 pixels (5th Generation, model: MP2F2LL/A, Software Version/OS: 15.2.1). The app requires a minimum API level of Android 7.0 (API level 24) and the minimum is iOS Version 11.0. The environment of the DailyBuddy application was developed using Unity Game Engine (version: 2021.3.12). The augmented reality feature was built using the AR Foundation 4.2.6 engine using the image target feature. Interviews were recorded and transcribed using three Android phones. The font used in the application is Valera Round, and its size is between 35 to 50 (pt). The size of images for the steps in the Image promoting condition was 512×512 (px), and printouts of AR icons were 10×10 cm. The application was developed as a collaboration of QL TechWorks [5] and Dan Marino Foundation [2].

3.2 Recruitment

Participants with mild to moderate autistic behavior were recruited through the Dan Marino Foundation [2]. The DMF is a non-profit institution that aims to empower autistic individuals and other developmental disabilities. The inclusion criteria for recruitment were: a) age between 18 to 65 years; b) diagnosed with ASD as confirmed by the DMF c) knows the English language (the app is developed in English) d) did not have any motor, visual, or hearing impairment. Alumni were recruited through emails and in-person activities or events, and students were invited to participate in the study only via in-person activities on campus. All participants were generally able to participate independently in research studies. The reading level of recruited students or alumni was reported to be at least a 5th-grade reading level (most participants were higher than that). Regarding the level of their verbal ability, most participants had spontaneous expressive verbal language. Although most participants were eligible to sign the consent form, we provided a parental permission form for the parents of participants and informed them about the study. All human-centric studies and interviews were conducted in person in March of 2023 at DMF.

3.3 Procedure

The informed consent forms and a pre-questionnaire were given to participants in person before the study day. An experimenter was available to answer participants' questions while filling out the pre-questionnaires. The pre-questionnaire

included demographic information, participants' placement along the autism spectrum, their living situation, and their previous experience with different chores. To protect participants' data confidentially, all participants had a color-coded participant tag showing the participant number and experiment condition (green: VP, orange: IP, and yellow: CP).

At the beginning of the experiment, the experimenter provided a short demonstration of the DailyBuddy application and introduced the two daily living tasks. Also, experimenters reminded participants that their participation was voluntary and they could leave the study at any time. Each study was divided into four sessions: washing the dishes, making the bed, post-questionnaires, and post-interview. Three experimenters conducted the study simultaneously, and one experimenter helped other experimenters prepare the experiment setting or take notes. The order of the two daily tasks was swapped between the two experimenters due to limitations in experiment materials and room availability. In addition, this order alternation can reduce ordering effects. Before starting each session, the experimenter scheduled two daily living tasks for the participant depending on the instruction method assigned to the participant. Figure 1a shows three screenshots of the app on how to schedule a new task (e.g., make the bed) in the DailyBuddy application.

At the beginning of each task, the app prompted participants to scan an icon to receive instructions on how to perform the task. Participants had the option to scan the icon and see an AR avatar prompting participants to the next level or skip the AR session and directly receive the instructions. Participants scanned the icons with minimal help from the experimenters; however, the image of the target icon and the instructions on what they needed to do were shown at the top of the application. Figure 1b shows several screenshots of the app on how to proceed with the app and see the AR avatar.

Participants received instructions on how to do each task via the app depending on their group condition in three formats: video, image, and checklist. A screenshot of the app for each instructional method is shown in Fig. 1c. Participants did not receive any verbal prompts from the experimenters except when they directly asked a question. At the end of each task, the app prompted participants to collect their coin rewards if they had finished their task. Also, participants were complimented by positive sentences such as "You did it" and "Excellent work." through an avatar. In addition to compliments and coins, the avatar showed the excitement of finishing the tasks through animation (see Fig. 1d).

After completing the two tasks, participants evaluated the system and their experience using the System Usability System (SUS) and User Engagement Questionnaire (UEQ). Finally, a short semi-structured interview was conducted to collect participants' feedback on the app. The procedural steps are detailed to facilitate the replication of this study in future research [13].

3.4 Participants

Initially, a total of 25 adults on the autism spectrum (18 male, 7 female) participated in the lab experiment, with a mean age of 21.04 (SD = 2.11), ranging

from 19 to 26 years old. Three participants needed a support level of three, seven required a support level of two, and the rest was on a SL1 (lowest). However, five of these potential participants who initially signed the consent form and filled out the pre-questionnaire were excluded from the findings of post-questionnaires for three different reasons: two participants (on SL3) were not able to complete the post-questionnaire and the answers of one participant to the post-questionnaire were recognized as not valid (SL3). Also, two other participants on SL1 were excluded due to signs of discomfort, instruction noncompliance, and data loss. The other twenty participants performed the lab experiment, completed the post-questionnaire, and participated in the post-interview. However, for the experiment data, we included the data we collected from 3 participants who could not fill out the post-questionnaire in our statistical analysis. Table 2 shows participants' distribution and demographic information among three instruction methods.

Table 2. Participant's demographic information among three instruction methods

	Participants Info	Video	Image	Checklist
Subjective Data	Num of Participants	7 (2f+5m)	6 (2f+4m)	7 (2f+5m)
	Average age (min-max)	20.7 (19-22)	22.2 (19-25)	20.7 (19-26)
	SL1, SL2, SL3	4, 3, 0	3, 3, 0	3, 4, 0
Objective Data	Num of Participants	8 (2f+6m)	7 (2f+5m)	8 (2f+6m)
	Average age (min-max)	20.5 (19-22)	22.3 (19-25)	20.5 (19-26)
	SL1, SL2, SL3	4, 3, 1	3, 3, 1	3, 4, 1

Figure 2 presents the pre-questionnaire data, including participants' experience with household chores and ethnicity. Additionally, characteristics associated with ASD are depicted in an ASD Pie chart. The severity of each characteristic is represented by four levels [4].

3.5 Settings, Materials, and Tasks

The experiment sessions occurred in two kitchens and two bedrooms at DMF during school hours. The school includes several rooms that have been used for teaching daily living skills such as doing laundry, cooking, and other general home living skills. We used four rooms for conducting the experiment: 3rd-floor kitchen (21' × 26'), 2nd-floor bedroom (11' × 11.5'), Tech room (24.5' × 19'), and 1st-floor Kitchen (21' × 15'). The bedrooms contained a single bed, a top sheet, two pillows, a duvet, and a fitting cover. The kitchens included a trash bin, a sink, a drying rack, towels, and four dishes (a mug, a plate, a fork, and a glass). Figure 3 shows the experiment environment while participants perform two tasks.

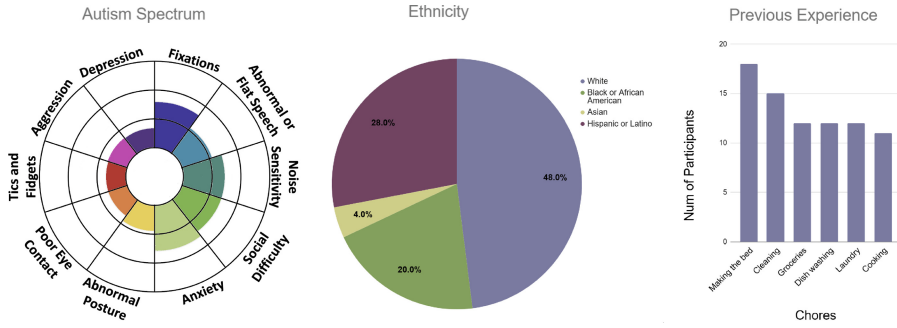


Fig. 2. a) Distribution of our participants in Autism Spectrum - the innermost ring represents Level 1 (the lowest level of autism), while the outermost ring corresponds to Level 4 (the highest level of autism) in the questionnaire. b) Ethnicity distribution c) Participant’s experience in different chores.

4 Outcome Measures

The study utilized the System Usability Scale (SUS) and the User Experience Questionnaire (UEQ) to gather participants’ subjective feedback on the application after completing both tasks. Objective measures included task completion time and accuracy or error rate. Experimenters used an observational form to assess user performance, recording details such as accuracy, errors, facial expressions, prompts, verbal expressions, and general notes. The start and end times of tasks were also documented. Additionally, participants’ screens were recorded to capture interaction data and timing during the study.

4.1 SUS and UEQ Questionnaires

To evaluate system usability and user engagement, participants completed SUS and UEQ questionnaires after completing two tasks [14]. The SUS and UEQ consist of nine and eleven questions, respectively, rated on a 5-point Likert scale (1: strongly disagree, 5: strongly agree). The final score is scaled to range from -100 to 100, with negatively worded items reverse-scored to maintain consistency. The distribution of participants’ responses to the SUS and UEQ is shown in Figs. 4 and 5, respectively, where different colors represent scores from 1 to 5. In the figure, red indicates a score of 1 (strong disagreement), while green represents a score of 5 (strong agreement). A greener color suggests a higher positive evaluation of the system, whereas red represents lower ratings, indicating disagreement.

The SUS results showed that 57% of participants reported acceptable usability, with no significant differences among groups (Kruskal-Wallis test). UEQ results indicated acceptable engagement for 52% (video), 60% (image), and 69% (checklist), with no significant group differences.



Fig. 3. Participants while performing: 1) washing the dishes 2) making the bed.

4.2 Task Completion Time and Accuracy

The task completion time for both tasks was measured to investigate the impact of instructional methods on user speed. On average, participants in the Video, Image, and Checklist groups took 514.5, 467.43, and 653.63 s, respectively, to complete the dishwashing task, and 317.25, 439.29, and 405.63 s to complete the bed-making task. As shown in Fig. 8a, the Image and Video conditions resulted in faster completion times for the dishwashing and bed-making tasks, respectively. However, statistical analysis using a one-way ANOVA test found no significant differences in task completion times across the groups.

The accuracy or error rate was measured to investigate the effect of different instructional methods on participants' performance. Accuracy was considered as the percentage of steps performed correctly by each participant during each task. We followed the definition of errors provided by Breznak et al. to measure the performance of autistic students while performing daily living tasks [10]. Participant's response was marked as correct if the next step was initiated within 10 s and the step was completed within a reasonable time after pausing the video or reading the instructions. Participants' performance was marked as an incorrect response or error if participants had the following errors.

- Latency error: If the student did not initiate a response within 10 s.
- Duration error: If initiated a correct response in 10 s but failed to complete the step within a reasonable amount of time for each step.
- Sequence error: If the student completed a step out of order according to the task analysis.
- Topographical error: if a student failed to complete the step correctly.

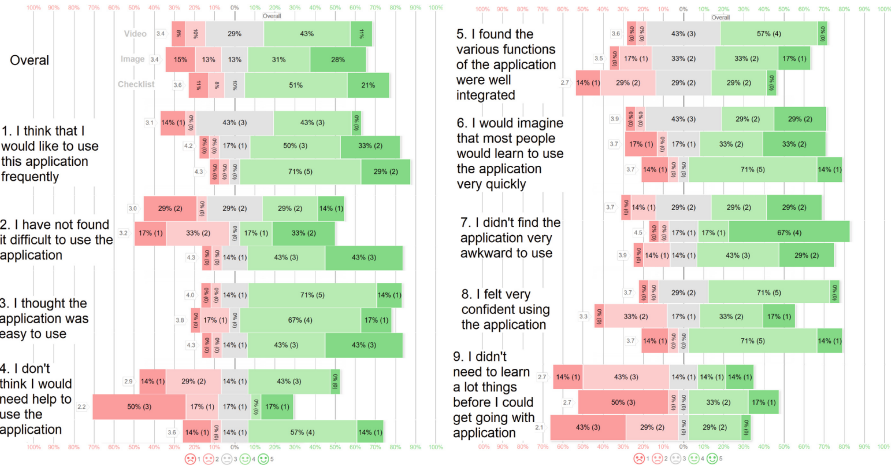


Fig. 4. Comparison of System Usability Scale for all three conditions: video, Image, and checklist.

The average success rate for video, image, and checklist conditions were 58.33%, 50%, and 54.17% for the washing the dishes task and 62.5, 65.31, and 60.71 for making the bed task, respectively. Figure 8b shows the box plots of the success rates. Overall, participants performed the bed-making task more accurately than washing the dishes. However, statistical analysis using a one-way ANOVA test found no significant differences in accuracy across the three groups.

The most common error type participants made during both tasks was topographical errors. Figure 7 shows the success rate and the percentage of each type of error for each task. This was measured by calculating the performance of each participant on each step of the task.

Some of the common topographical errors participants made during the washing the dishes task were washing dishes one by one instead of some at once, remaining soap on the dishes after rinsing the water, and air-drying the glass item while the app prompted to towel dry, throwing the leftovers on the sink instead of trash bin. Topographical errors that participants made during the making the bed task included not removing all the pillows and sheets, tucking the comforter or duvet underneath, folding back the comforter with a noticeable difference from what the instruction asked (6 in.), not tucking the top sheet under the mattress, folding back the top sheet instead of a duvet, was not able to perform the task alone and the experimenter helped the participant.

Three different observation behaviors were seen among the participants; some participants watched/read all instruction steps at once, some watched/read it step by step while making progress toward the task, and the rest only watched/read the instructions partially. Table 3 shows for each condition and each task what percentage of users showed each observation behavior. As the



Fig. 5. User Engagement Questionnaire for a) Video b) Image c) Checklist.

data shows, none of the users watched all the images at once, while this behavior was observed more for video. Also, in total, more participants watched or read the instructions completely for making the bed task. This might be due to the fact that using the app with a hand-held device while washing the dishes was less convenient for the participants.

4.3 Performance for Three Support Levels

The bar charts presented in Fig. 6 depict a comparison of participants' task completion time and accuracy across three autism support levels. The findings indicate that, as anticipated, participants in SL1 achieved a greater degree of accuracy in comparison to those in SL2. Similarly, participants in SL2 exhibited a higher level of accuracy than those in SL3 for both experimental tasks.

5 Interview

After completing two tasks and post-questionnaires, participants took part in a semi-structured interview, recorded and transcribed via Android phones. At

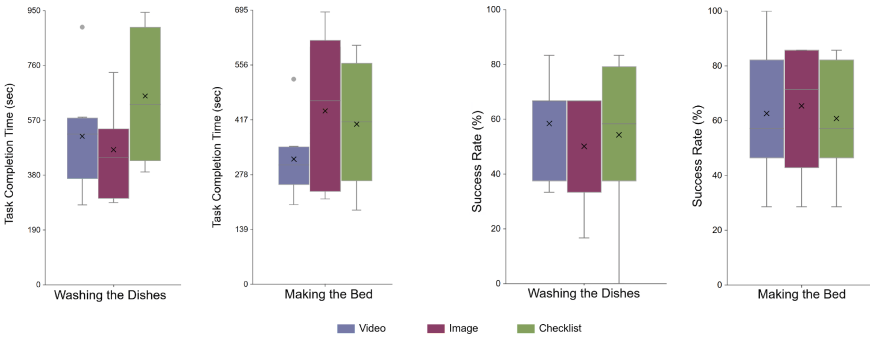


Fig. 6. Comparison of participants’ performance based on the level of support group they are in (SL3: 3 participants, SL2: 10 participants, SL1: 10 participants)

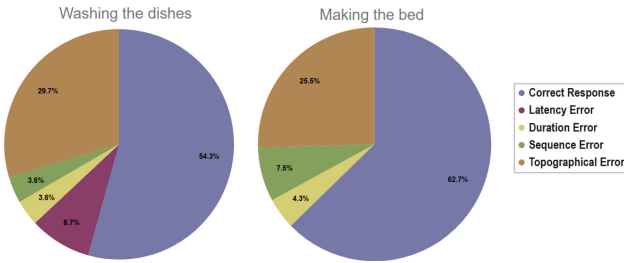


Fig. 7. Distribution of participants’ error types for two daily living tasks.

Table 3. The distribution of observation behavior among participants for each condition in the two tasks

Observation	Washing the Dishes			Making the Bed		
	Video	Image	Checklist	Video	Image	Checklist
Complete (all at once)	50%	0%	25%	50%	0%	0%
Complete (step by step)	12.5%	42.9%	37.5%	25%	100%	87.5%
Partial	37.5%	57.14%	37.5%	12.5%	0%	12.5%

the beginning of the interview, participants were reminded that there were no wrong or correct answers to the questions. The average interview time was 316 sec (STDV: 177), ranging from 112 to 745s. The interview included ten questions focusing on user feedback, task difficulty, app features (AR avatar, scanning icon, instructions, and coin rewards), and potential improvements. Questions were adapted from previous mobile application evaluations and modified for DailyBuddy [20,30,38]. We used thematic analysis for analyzing the interview data. The interview recordings were first transcribed into a text format. Then, we assigned meaningful labels to data segments (for example, if participants

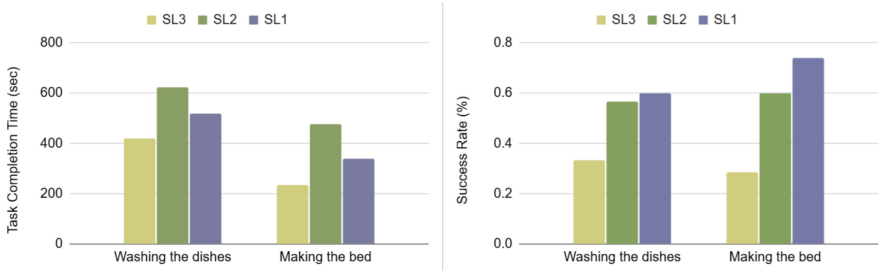


Fig. 8. a) Comparison of task completion time for each task among three experimental conditions (video, image, and checklist) b) Comparison of success rate for each task.

described with positive words, such as “straightforward,” “easy,” etc., we labeled that as “not difficult”).

The answers to the general feedback question from participants showed a positive opinion of the DailyBuddy application and its usefulness. Below are some examples of the feedback we received. P[SL2, IP, m]: “It was nice, and it was pretty satisfying; it kind of helped me a little bit throughout each task. Something new!”. Another participant[SL2, CP, f] who followed all the task steps carefully commented, “I felt happy about it. Again because they can teach me to learn how to do things on my own instead of being lazy all the time.” P[SL1, VP, m] stated: “It was great. It helped me with some problems I know I have difficulty with. It usually helped me.”

In response to questions about the difficulty of the app, 76% of participants stated the application was not hard for them. Also, two participants mentioned the app was difficult to use, but it turned out it was because the task was complicated for them, not how to use it. One participant mentioned that the app was hard to use because she didn’t know which button to use to start. The results from the interview regarding the users’ experience with scanning the icon showed that the most challenging part for the users was scanning the icon for several reasons: finding the icon’s location in the room (2 participants) and not working the scanning part (1 participant). Also, four participants mentioned it was hard at the beginning, but after they learned how to use it got easier for the second task.

Avatars can incorporate various features depending on specific needs [11, 12]. We asked participants for their opinions on the DailyBuddy avatar to determine if any features needed to be modified or added. Based on the interview feedback, several participants shared that they would prefer an alternate appearance for the avatar. Here we listed some of the interesting feedback we received:

- P[SL2, VP, f]: “I was curious; it would be cool if it were an animal. Yeah, specifically Owl. But if it had more options, it could change to other animals. I like different options.”
- P[SL1, IP, m]: “Looked very professional; I liked it wears more casual clothes when it helps to do chores.”

- P[SL1, CP, m]: “I mean, the avatar is fine. But I felt the avatar was very realistic, but the app was simple. But it was not that bad; it was good.”

Feedback from participants who liked the way that avatar looked:

- P[SL1, VP, m]: “That was kind of cool; it was like a teacher assistant.”
- P[SL1, IP, f]: “It looks like a game to me which is super awesome to me. It looks like the Avatar movie.”
- P[SL2, CP, f]: “So you thought it would pop out like in reality.”

Our interview data showed that 73% of participants found the instructions easy to follow and beneficial. Two participants in the Checklist group appreciated the checklist for helping them stay on track (P[SL1, CP, m]: “I felt confident of seeing the to-do list. It helped me to get on track to not miss anything”). However, one participant found a dishwashing step unhelpful and misleading. Another participant in the checklist group mentioned although the task was easy for him, autistic students who are in a severe or medium condition might need visuals (e.g., a visual gif). A participant in the Image group preferred a more immersive experience, such as a video demonstration (P[SL2, IP, m]).

All participants had a consensus on the positive effect of coin rewards. However, one participant mentioned that although the coin system was great, he believed that it should not just be based on the number of coins earned, as that could have a negative impact on some users. Instead, he suggested that the coins should be given based on user performance and should be used mostly as a statistical tool for parents and vendors who are in a role-functioning [SL1, CP, m]. Findings from the interview show that participants favored coin rewards for various reasons: some participants found it rewarding, receiving approval of the task, feeling happy, and satisfying. Experimenters observed the excitement and happiness among several participants while receiving the coin rewards:

- P[SL2, VP, f]: “Huraay, huraay, It was good, Sounds good.”
- P[SL1, VP, m]: “It did help. It approves how much work you’ve done. Like, how you did your job like in a real job when you get paid on the paper.”
- P[SL1, IP, f]: “I felt happy when I saw it.”
- P[SL1, CP, m]: “I think it is good, a good way to reward doing tasks, satisfying too.”

6 Discussion

This study aimed to examine whether adults with autism acquire daily living skills differently based on the instructional methods in DailyBuddy. All participants with ASD successfully used the application. However, the most effective instructional method varied among individuals and tasks.

So, could autistic individuals benefit from the three instructional methods provided by the DailyBuddy application for learning their daily living tasks? We believe that DailyBuddy can improve the performance of people with ASD and

motivate them to do their chores, given the experiences with our participants. However, a few improvements can be proposed to make the positive impact of DailyBuddy more significant.

The experimenters observed that most participants followed the instructions sequentially, performing each task before moving on to the next step. However, when it came to the VP, half of the participants in both tasks watched the entire video at the beginning rather than following the prompt to watch the video at specific points throughout the task. This observation could have implications for the design of instructional materials and the way tasks are presented to participants. It may suggest that some participants prefer to have all the information upfront before beginning a task, while others prefer to receive information in smaller chunks.

Participant feedback on app changes mostly focused on the avatar's features, such as gender, clothes, and voice. For example, one participant preferred a male avatar, while another disliked the avatar's voice tone. Since the study focused on instructional methods for autistic adults, participants couldn't explore or customize additional app features. However, DailyBuddy includes a store with various avatar bodies, clothing options, voice tones, and backgrounds.

In addition to avatar appearance, several participants mentioned they would like to use the app in the future if it includes tasks they prefer, such as gardening, doing laundry, and folding clothes. The app supports over 30 presets of daily tasks in seven main categories: Chores, Routines, Hygiene, Health, Pet, Safety, and Others. The app's diverse range of tasks could potentially boost user preference and engagement.

7 Limitations

Since our target group was adults, most of them had already experience in doing chores. However, our observation showed almost all of the participants were challenged with performing the task and needed help to fix some of the errors. While prior knowledge can help participants perform the task more easily, it can also hinder learning. One common issue is when users learn a different way of doing tasks or develop incorrect assumptions that conflict with the way the task instructions are taught by the app. As an example, in the washing the dishes task, although the app prompts participants to wash dishes a few at a time, most participants washed dishes one by one based on their previous experience and therefore struggled to adapt the method.

In addition, we had a small sample size of three for the group at SL3, and due to no-valid responses or not being able to complete the post-questionnaire, we could not collect their feedback by SUS and UEQ. Also, a sample size of 3 cannot be considered representative of individuals with ASD in SL3 to generalize this study's findings on whether this target population can independently learn and autonomously perform daily living tasks using the DailyBuddy.

8 Conclusion

This paper introduced a mobile-based interface called DailyBuddy that aims to help individuals with ASD by teaching them how to perform their daily tasks, such as washing the dishes, doing the laundry, etc. Our findings showed that adults with autism can benefit from different instruction methods provided by DailyBuddy. Yet, there is little research available on the best methods for teaching daily tasks depending on the task and target population. Our goal for this study sought to illuminate this question by summarizing the feedback from the participants and data characterizing their performance for three different instructional methods.

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