Development and Usability Testing of a Web-Based Adaptation of the Joint Attention, Symbolic Play, Engagement, and Regulation Social Communication Intervention

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ABSTRACT

Purpose: Technology-enabled adaptations of efficacious in-person early intervention programs for young children with autism spectrum disorder have the potential to conserve resources while increasing access to specialized educational services. Usability testing of online programs can support participant engagement by aligning program navigation and content presentation with the needs and preferences of the target end users.
Method: The project includes formative work to develop a technology-enabled adaptation of the evidence-based caregiver-mediated Joint Attention, Symbolic Play, Engagement, and Regulation (Kasari et al., 2010) social communication intervention to be delivered by community-based early interventionists and early childhood special educators who are serving families of young children with autism in rural and remote communities. Usability testing included two components: (a) Think Aloud real-time feedback interviews (Davison et al., 1997) and (b) completion of the System Usability Scale (Sauro, 2011). The measures were conducted to explore the stakeholders' interactions with the system.
Results: Feedback was largely positive indicating that the online materials were straight forward to navigate, the content was valued, visuals enhanced the experience, and multiple methods to access information (e.g., listen or read) were appreciated. Suggestions for improvement included adding further video examples, reducing page scrolling, and making some activities optional (e.g., text boxes, multiple-choice questions).
Conclusions: Overall, participants smoothly navigated through the pilot materials. Revisions are being implemented to incorporate the participants' feedback.

Caregiver-mediated interventions can support caregivers' adoption of strategies to support social engagement and communication for young children with autism spectrum disorder (ASD). However, such interventions are primarily delivered in-person using active strategies such as

coaching, which are resource intensive and often inaccessible to families who are living in rural and remote communities. Technology-enabled adaptations have the potential to conserve resources while increasing access to specialized educational services. Yet, the process to develop asynchronous online materials and synchronous supports require time and engagement from researchers and community stakeholders to align the program with the needs and preferences of the end users. Usability testing is a process designed to engage stakeholders in program development by obtaining their feedback through methods such as interviews, focus groups, and questionnaires. This feedback

can include suggestions to revise the program to enhance the users' experience (Maramba et al., 2019). Such processes are considered key components of the development of electronic health programing (Zapata et al., 2015). The current project will describe formative work to develop a technology-enabled adaptation of an evidence-based caregiver-mediated social communication intervention through usability testing with early intervention (EI) and early childhood special education (ECSE) practitioners as well as caregivers of young children with ASD.

Caregiver-Mediated Interventions for Families With Children With ASD

The inclusion of caregivers is central to recommended EI practices with young children (Division for Early Childhood, 2014). Unlike clinician-mediated interventions in which the practitioner works directly with the child, in caregiver-mediated models, the complexity of program delivery increases because the intervention strategies are transferred to adults in the child's family for use in their everyday interactions with their child (Bearss et al., 2015; Wetherby et al., 2014). Findings from meta-analyses indicate that such practices when "delivered in-person" have led to demonstrated gains in social communication (e.g., Nevill et al., 2018) and reductions in challenging behavior (e.g., Ratliff-Black & Therrien, 2021) for children with ASD.

Technology-Enabled Interventions

Prior to the pandemic, technology-enabled assessments and interventions have demonstrated promising early findings that suggest further exploration of program feasibility, efficacy, and effectiveness is warranted (Ellison et al., 2021), including caregiver-mediated programs (Unholz-Bowden et al., 2020). Technology-enabled interventions have the potential to augment supports that the child and family may be receiving through schools and in-person intervention services (Simacek et al., 2021). However, for families living in rural and remote communities, online services may be the only option that can be offered with frequency or intensity for children with special needs (Marcin et al., 2016). Families have expressed a desire for safe and evidence-informed online service options (Hermaszewska & Sin, 2021). In response, multiple online programs are in development including standalone asynchronous psychoeducational programs as well as programs that combine synchronous live and asynchronous supports. In a systematic review including 62 telehealth interventions studies, 95% of studies reported significant gains for caregivers' knowledge and implementation outcomes (Chi & Demiris, 2017). Furthermore, review of applied behavior analytic interventions also indicated gains but highlighted methodological limitations of the largely single-case experimental literature, including limited experimental control, unstable baselines, and lack of blinded outcome raters (Ferguson et al., 2019).

Standalone asynchronous approaches were reported less frequently in recent reviews (e.g., only 13.6% of the studies reviewed by Simacek et al., 2021) and are more often paired with a synchronous component. Exploration of user engagement in asynchronous online materials for families with young children with special needs has been limited, although small pilot studies have indicated positive findings. For example, in a randomized trial, Nefdt et al. (2010) reported gains in caregivers' implementation of pivotal response teaching (PRT) strategies and children's spoken utterances using video-recording PRT content. Furthermore, Ingersoll et al. (2016) compared access to self-directed online Project ImPACT materials to the addition of therapist assistance. On average, families in both conditions made gains over time; however, those in therapist-assisted intervention scored significantly higher in their use of the program strategies and children's observed language (including prompted and spontaneous utterance combined). Examination of the usability of Project ImPACT self-directed web materials, treatment acceptability, and overall satisfaction were associated with program completion (Ingersoll & Berger, 2015).

Online interventions including those designed for mobile applications have a more substantive history in the field of mental health including depression and substance use (review: Bradway et al., 2020). Based on this literature, recommendations to support user engagement in online programs have been developed. For example, Wei et al. (2020) found that interface aesthetic (e.g., color scheme, screen presentation), navigation (e.g., user input, search, menu), personalization (e.g., individualized feedback, preferences), reinforcement (e.g., incentives, reminders), communication (e.g., access to others with similar experience, access to providers), message presentation (e.g., nontechnical language, positive nonjudgmental tone, presentation of quizzes, fonts, etc.), and credibility (e.g., privacy, absence of advertising) are key design features to support user engagement in electronic health programs. Furthermore, Bakker et al. (2016) have reported recommendations for 16 key features in mental health applications. Although some items are content specific (e.g., addressing anxiety and low mood), nine items are relevant to broader usability including being designed for use by nonclinical populations, automated tailoring (e.g., use of participant data to personalize the intervention to the needs of the participant), real-time engagement, encouraging nontechnology-based activities, gamification and intrinsic motivation to engage, log of past application use, reminders to engage, simple and intuitive interface and interactions, and experimental trials to establish efficacy (Bakker et al., 2016). Overall, the literature highlights the importance of attending to the

development of program features with participant engagement in mind.

The Current Study

Among the programs included in a review by Simacek et al. (2021), 81.8% of the studies primarily targeted children's communication, and over 30% of programs included naturalistic developmental behavioral interventions (NDBIs: Schreibman et al., 2015) that have been adapted into an online format, including the Early Start Denver Model (Vismara et al., 2018), Project ImPACT (Ingersoll & Berger, 2015), and PRT (McGarry et al., 2020). Caregiver-mediated Joint Attention, Symbolic Play, Engagement, and Regulation (JASPER; Kasari et al., 2010) is also considered a NDBI. When delivered in-person through coaching and brief discussion with families including toddlers, preschool, and school-age children with ASD, findings demonstrate gains for children's engagement, play, and social communication (Kasari et al., 2010, 2015) as well as caregivers' strategy use (e.g., Shire et al., 2015). Furthermore, pilot single-case experimental data indicate that synchronous live online coaching by community interventionists has also led to gains for caregivers' strategy use and children's joint engagement (Shire et al., 2021). However, online asynchronous JASPER materials have yet to be developed and tested.

In the context of a community-based participatory research (CBPR; Minkler & Wallerstein, 2003) project, the current study describes development activities from the initial year of a larger 4-year intervention project that focused on the iterative development of JASPER online intervention materials that will be used as one component of adaptive intervention sequences for families with young children with ASD. The formative development work has engaged both EI and ECSE practitioners as well as caregivers of children with ASD. In the current study, the aims were to, first, explore initial user experiences of both caregivers and practitioners through qualitative interviews and a quantitative usability questionnaire and, second, to develop revisions to the online program presentation and content based on the users' feedback.

Method

Research Design

The project was a collaboration between Educational Service Districts in the state of Oregon and the research team. The CBPR project was guided by the Active Implementation Framework (Metz & Bartley, 2012), which specifies four separate phases: exploration, installation, initial implementation, and full implementation. The exploration phase involves key stakeholders to examine the fit of the intervention within the community where development work may be conducted with the core intervention prior to venturing further toward implementation (Metz & Bartley, 2012). Usability testing was an essential component of the Plan–Do–Study–Act improvement cycle to actively engage the target program end users in the development and iterative revision of the online materials. This formative work was central to the initial development year of the larger 4-year implementation project that was focused on building the online materials and staff training in the JASPER intervention.

Online Intervention Materials

The JASPER intervention is a comprehensive social communication intervention that targets children's spontaneous play skills, nonverbal and spoken communication, and social engagement (Kasari et al., 2021). The caregiver-mediated JASPER model includes play with toys as well as daily home activities such as meals, books, feeding pets, bath time, and so forth (Kasari et al., 2014). In either context, caregivers are provided with children's goals (e.g., communication, play) and supported to select materials at the child's developmental level and set up the home environment for the selected activities. Caregivers are supported to establish routines through imitation of children's appropriate actions/communication and modeling as needed to teach new skills. To build on this foundation, advanced intervention strategies are then introduced including expanding the diversity and complexity of the routines, creating programmed opportunities for social communication, and tailoring supports for the child's engagement and regulation (see Appendix for JASPER intervention strategies).

The pilot online materials follow this sequence. The content and strategies are split into modules that take about 3–10 min to complete. Each module frames the information using *wh*-questions (e.g., What is imitation? Why do we imitate? When do we imitate? When do we not imitate? How do we imitate? etc.). The modules are designed to be highly visual using illustrations, graphics, and video with bulleted brief text (see Figure 1). Participants may listen to audio commentary, read the text caption of that commentary, or both. The site is enabled for mobile use, so a participant may engage on their computer, tablet, or phone.

Each participant is provided with a unique login. This allows the participant to return to their last viewed page each time they log in. The online materials were designed to be paired with contact with a community JASPER-trained interventionist to help individualize the content to the needs of the family and support the caregivers' implementation of the strategies with their child as

Figure 1. Example online program page.

needed. The amount and type of support provided by the community interventionist while the families work through the online materials will be examined in a future pilot randomized trial.

Participants

A total of 17 participants engaged in online individual usability testing sessions. Participants were recruited through electronic flyers distributed by graduate students and the projects' community partners in educational service districts as well as university social media. Eligible practitioners were actively engaged in EI/ECSE services in Oregon, and caregivers had at least one child of any age who was on the autism spectrum.

The study was approved by the University of Oregon Institutional Review Board. All participants received a copy of a written consent form to review prior to the appointment, and we were welcomed to ask questions prior to signing. All participants provided electronically signed consent prior to starting the user testing appointment. The research team member reviewed the protocol and confirmed permission to record the session at the start of the appointment.

Practitioners

Six female practitioners working in EI and ECSE programming participated. Practitioners' roles included EIs ($n = 2$), ECSE teacher ($n = 1$), speech-language pathology assistant ($n = 1$), speech-language pathologist ($n = 1$), and occupational therapist ($n = 1$). They reported working in the field an average of 13.5 years ($SD = 9.84$) and in their current positions for 6.93 years ($SD = 8.06$). One practitioner was also a parent of four boys including a child on the autism spectrum. The practitioners were unfamiliar with the interviewers apart from one participant who was familiar with the interviewer through consultation in her district.

Caregivers of Children With ASD

Eleven caregivers of children with ASD engaged in usability testing. The caregivers were primarily female ($n = 9$), have an average age of 36.27 years ($SD = 3.72$ years), and were White ($n = 10$) and Asian ($n = 7$). Caregivers had completed some high school ($n = 1$), high school ($n = 1$), vocational degree ($n = 1$), associate degree ($n = 1$), bachelor's degrees ($n = 2$), and graduate degrees ($n = 6$). Seven caregivers reported English was not their first language. Caregivers reported having one to two

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children each with one child on the spectrum. The child with ASD was, on average, 5.05 years of age (*SD* = 2.62). Nine caregivers were unfamiliar with the interviewers while two had engaged in prior programming for their children with members of the research team.

Measures

Usability testing included two components: (a) Think Aloud real-time feedback interviews (Davison et al., 1997) and (b) completion of the System Usability Scale (SUS; Sauro, 2011).

Think Aloud Interviews

The Think Aloud interviews (Davison et al., 1997) were conducted one-on-one by the authors (including a researcher with PhD and doctoral students) to gather the stakeholders' feedback about their interactions with the system. Derived from cognitive science, the "think-aloud" procedure asks participants to talk about their thoughts and experiences in real time while actively engaged with the online modules. To begin the 60- to 90-min session, each participant was provided with a brief introduction to the JASPER intervention including an overview of the history, research evidence, and target outcomes as well as the larger research project. Participants were then provided with access to the program website and guided to the first of two modules they would view. Each participant engaged with one content module focused on children's development (e.g., play skills, social communication) and one module that introduced a core JASPER strategy (e.g., play routines). Participants were asked to explore the site at their own pace. They were invited to read and/or listen to the materials and to take their time exploring the features of each page. They were asked explicitly to speak out loud their thoughts, comments, concerns, and questions. Participants were assured that there were no right or wrong answers and that the team was seeking their feedback to better the materials for families. The interviewer enabled the participant to share their screen in order to see the specific features that the participant was describing. Participants engaged in the sessions using a mix of laptop computers, tablets, and smart phones. Sessions were conducted and recorded on Zoom and then transcribed to gather participants' feedback as they navigated two program modules as well as identified features, functions, and/or content that required further development. The first author checked all interviews for adherence to the Think Aloud protocol. All interviews included all core components, including permission to record, introduction to the intervention and the project, think aloud engagement in one content module and one strategy module, and summary discussion.

SUS

The 10-item adapted SUS questionnaire addressed program acceptability including how easy the system is to use, challenges, and participants' confidence to use the system (Sauro, 2011). Each question was scored from *strongly agree* (score of 4) to *strongly disagree* (score of 0). For items where disagree represented a positive view of the program (e.g., I found the system unnecessarily complex), the numerical score was reversed (*strongly disagree* = 4, *strongly agree* = 0), such that a higher total score summed across the 10 items represented a more positive perception of usability and learnability. Following published scoring procedures (Brooke, 2013), the total item scores were summed and multiplied by 2.5. The total possible score ranges from 0 to 100. Total scores in the 90s indicate exceptional user experience, 80s indicate good, and 70s indicate acceptable (Bangor et al., 2009). Both reliability of the SUS scoring and the validity of the scale have been published (e.g., Brooke, 2013; Sauro, 2011).

Interview Transcription and Analyses

Video-recorded interviews were transcribed by members of the research team including graduate and undergraduate students. The Rapid Qualitative Analysis (Vindrola-Padros & Johnson, 2020), an approach developed by Hamilton (2013), was applied. The validity of the Rapid Analysis approach has been examined in comparison to traditional qualitative coding and thematic analysis, indicating that similar results can be obtained with lesser time and cost (Taylor et al., 2018). Following steps outlined by Hamilton (2013), a summary template was developed to apply to each transcript. The summary template included six domains (web features and navigation, content and delivery, knowledge checks, handouts, language, and other observations) that were intended to address aspects of the structure, flow, and content of the site. The summary template was developed and then tested by three team members to assess if the chosen domains were fitting, look for redundancies, and assess if any domains were missing. Each member applied the summary template to one transcript and then met to review the summaries for consistency and revise the template. No major revisions were made to the template after this initial pilot run. The template was then applied to each of the 17 transcripts. The template summaries were designed to be brief, organized by domain, and provide a readable and thorough bulleted list of key points for the content of the transcript in no more than 1 hr (Hamilton, 2013).

The information from the summaries was then transferred into a data display matrix created in a Microsoft Excel worksheet (Averill, 2002). The matrix included a list of respondents on the *y*-axis and the domains from the summary panel on the *x*-axis. The matrix could then

be read across a row to obtain a summary of a single participant's responses or read down a column to gather the collective views of the group of participants within a domain. The matrix supported a streamlined process to systematically analyze similarities, differences, and trends in responses provided by the full group of participants (Averill, 2002). These themes are presented in the Qualitative Results section.

Results

Quantitative Results

All 17 participants completed the SUS after engaging in the Think Aloud procedure (see Table 1 for SUS scores by question). The average score for practitioners was 87.0 (SD = 8.94), and the average for caregivers was 83.86 (SD = 10.08). With scores in the 80s indicating a good experience (Bangor et al., 2009; Sauro, 2011), these scores indicate that the participants found the preliminary materials to be usable.

Qualitative Results

A summary of overarching themes from the Think Aloud interviews are listed in Table 2 and then described in the text below.

Web Design, Functions, and Navigation

Overall, participants provided positive feedback about the general look and feel of the site and opportunities to choose to read and/or listen to the material.

* "I like the fact that you can listen to it and/or read it. I think that that's really – makes it really accessible to a lot of families."

* "I think the illustrations are great, I think that it's not too wordy, which is really nice. It's very clear and concise, like examples of what your child might do."
* "I really like the colors, they're not too bright. Like, in the image. They're bright enough to catch your attention but they're not so bright that they make your eyes kind of hurt or anything."
* "I like it (graphic). And I love the little characters, too. They're super cute."
* "I really liked the videos. It's nice as it's not too overwhelming."
* "I think it (repeating the video) makes sense. I think it's great. Repetitions are always good for teachers and caregivers."

Although the participants indicate that the site was uncomplicated to navigate, a few participants commented specifically on the scroll bar that was used to move up and down the page. Each page presents visual information (e.g., video, graphic, or illustration) with the audio play button and corresponding written text captions of the audio commentary below the visual. Due to the size of the visual and amount of corresponding commentary, some pages require the participant to scroll to see both the visual and the commentary text.

* "I think it's pretty easy to navigate between like, the different bites."
* "It's nice that it's broken up, it's not just one long duhduhduhduhduh."
* "It's nice and short chunks for parents, so it wasn't a lot to take in at one time."
* "Even if you could shrink…um the picture or...? So, the picture is on the same page as well as the box to click for the audio."
* "One of my comments would be that I am constantly scrolling up and down on the side bar."

Table 1. System Usability Scale (SUS) results.

SUS item	Percentage of scores				
	0 (negative)	1	2	3	4 (positive)
1. I would like to use this system frequently	0%	0%	5.8%	35.3%	58.8%
2. I found the system unnecessarily complex[a]	0%	0%	23.5%	35.3%	41.2%
3. I thought the system was easy to use	0%	0%	0%	52.9%	47.1%
4. I think I would need the support of a technical person to be able to use this system[a]	0%	0%	11.8%	29.4%	58.8%
5. I found the various functions in this system were well integrated	0%	0%	17.6%	58.8%	23.5%
6. I thought there was too much inconsistency in this system[a]	0%	0%	11.8%	35.3%	52.9%
7. I would imagine that most people would learn to use this system very quickly	0%	0%	0%	41.2%	58.8%
8. I found the system very cumbersome to use[a]	0%	5.8%	17.6%	35.3%	41.2%
9. I felt confident using the system	0%	0%	0%	47.1%	52.9%
10. I need to learn a lot of things before I could get going with this system[a]	0%	0%	5.8%	29.4%	64.7%

[a]Scoring reversed.

Table 2. Summary of comments from Think Aloud sessions.

Domain	Comments
Web design	Reduce scrolling
	Endorsed self-paced design
	Liked how information was "chunked" into smaller sections
	Liked progress dots and being able to return to the last completed page
	Liked being able to choose to listen to audio or play video
Content	Content is applicable and relatable
	Highlight "why" information and explain up front
	Include examples of strategy use during daily routines
Content presentation	Videos and pictures are supportive of text and narration
	Include more examples of a range of skill levels in videos
	Consider restructuring or adding to concept graphics (i.e., engagement, diversity, complexity)
Knowledge checks	Add immediate feedback for answers to individual questions
	Make responding to the questions optional
	Keep to 1–3 questions
Handouts	Helpful and encouraging resource
	Like that these handouts can be printed or saved electronically
Language	Parent friendly, glossary helps with key terms
	Look for opportunities to shorten text when possible
	Consider adding more video examples for technical concepts
	Liked glossary words
Other observations	See need for interventionist contact as part of the program
	Appreciated opportunities to input personalized information (e.g., materials at home)
	Can clearly see the program being individualized to family needs

In recognition that caregivers may need to jump on and off the site throughout the day with only short periods to engage at a given time, the site is designed to save the last page viewed and bring the participant back to that same page the next time they log in. Participants appreciated this feature as well as visuals of progress including the progress bar present on each page. Participants had additional ideas to indicate progress including check boxes in the navigation panel to reinforce progress.

- "It is nice how you can go back and review what you read just in case if you left off somewhere in the middle of an appointment."
- "Also like for example when we finish one, maybe we can...checkmark that we finished this one."

Program Content and Presentation

Participants described the content as relevant, important for children, and relatable. Two modules were made available during each user testing session. One module introduced a core child learning domain such as engagement (how children connect with people and objects in their environment), play skills, and social communication (nonverbal and spoken skills to request and to socially share). The second module introduced an intervention strategy (e.g., establishing the base of a routine).

- "I think this (equal and active partners) is a good concept."

- "I really like the key elements on the website. It touched on key points."
- "I like this one. More regulated more chances to learn. That's beautiful. That's a very visual nice, simple one."
- "I love the expansion of the activities (play routines) that are put in here."
- "I think often times we are so busy trying to direct that play that you forgot to step back and let that child have some processing time...that it's a good reminder. It's kind of following their lead."
- "It's validating that most children spend their time on object engagement. That's important to parents."

Participants also reported that they liked the presentation of the information using graphics, videos, and illustrations. Some participants requested additional video or animation to provide additional examples of strategies or concepts. Furthermore, two participants noted a desire for longitudinal video that could display progress over time.

- "I thought both modules were great. They were very informative, easy to read, umm makes me want to know like where do I start with a child who is not engaging. So, it makes me want to learn more. Yeah!"
- "I really like the consistency of the setup, again I like the consistency of the images, um, how – how we're building the skills."

- "It would be better if you can find videos that tell this kind of stories. These videos would be more persuasive, and parents would have more patience with their child because they know what it looks like at different stages."

Several participants noted the importance of the explanations of "why" a child skill or intervention strategy was important for the child's learning. The participants indicated that this information should be placed up front in each module and some participants expressed a desire to connect the "why" to typical developmental milestones.

- "I think if we put the why engagement, the important you know up front…maybe it…kind of force people to put attention to it, to why it's important because people are always seeking purpose you want to say why we are doing this, why is it important."
- "We need to hook them…."
- "I like the background about why you are doing it."
- "In my experience play is like oh they're just playing with toys, this is a really good breakdown of what it means, and why it's important."
- "I like that it talks about why they might be doing it and what it will look like again [engagement]"."
- "It would be helpful to know what typical developmental play milestone are."
- "I don't know that there's necessarily great information for families out there on what is typical [for play]"

Knowledge checks. Some participants recommended adding more choice elements to the knowledge checks (multiple choice and true/false comprehension questions), such that participants could complete some or choose to skip them altogether. Views were mixed on the placement of the questions, with some participants suggesting spreading the questions throughout the module and others preferring a set of summative questions at the end of a module. In addition, participants suggested adding individual explanations of the answers for each question that should be provided immediately to the participant upon submission of their answer rather than a summary explanation for a set of questions.

- "I think it is important to have people, kind of check in with this stuff. Because, um, you know – or even if they did it, again with like an interventionist talking about it (knowledge check)"
- "I would prefer to skip the questions."
- "I think it is good if we can complete knowledge check questions throughout the class."
- "I think just having those questions would help break that up a little bit. And have a little bit of

involvement versus just sitting and listening. I think that would be nice, that would add to it."
- "Maybe after the whole course and then just a few questions"
- "If there are shorter and fewer questions, we can spend some time on them. If too much, I will take it as a task."
- "In terms of the amount of questions, I think there is no problem with it. Pretty good, and I can tell how much I have understood by completing these questions."
- "I do think that the answers or explanations to the that even the correct answers as well as the wrong answers could be, could be helpful."

Handouts. Participants reported uniformly positive feedback on the summative handout provided at the end of each module. Each handout included graphics and illustrations to represent the key concepts and strategies presented in the module. The handout can be saved or printed to be used as a reminder by the participant.

- "I do like something that they can print out, and hang on their fridge"
- "Like it's not a lot of words, the visuals bigger and it shows the steps. I like that. Handouts are great especially it's one page."

Language

Participants provided mixed feedback about the program language where some participants found the level and amount of language in the program appropriate while others suggested swapping out some intervention terminology (e.g., engagement) for lay language replacements. Participants noticed and made positive comments about the bolded key words. The key words are used to define core terminology/technical language such as "engagement." The bolded words are linked to glossary of terms and provide a pop-up definition of the term whenever it is used in the materials.

- "You are using the same language throughout, so that's helpful."
- "It feels very parent friendly in the writing, it's not – obviously – too technical, it makes a lot of sense."
- "It was very easily written. Really easy for someone to understand that had not had a lot of training with different things."
- "I think you can include more pictures and shorten texts as much as possible."
- "It would be better if there were more detailed examples. That is to say. It would be better if there were more pictures, examples, and explanations."
- "I liked the glossary of terms."
- "You bolded out some of the key words. Love it."

Discussion

Overall, both practitioners and caregivers provided positive feedback about their user experience including the style, color and organization of the content, navigation, as well as the program characters, video, and graphics. This overall positive user experience is reflected in the users' quantitative feedback where SUS scores in the 80s indicated a "good" user experience. Suggestions to increase usability included adding more video examples, increasing options for engagement with the comprehension questions (knowledge checks), reducing scrolling within a page, and moving the placement of the "why" for each strategy to the front of each module. Incorporation of the suggested revisions attempt to balance a mix of participant viewpoints as well as create additional opportunities for further participant input as the project moves into a larger pilot research trial.

Balancing Length, Complexity, and Examples

Overall, participants were positive about the sectioning of the content and time to navigate the information. There were three areas where additional content requests brought the question of balancing brevity with further to the forefront: (a) increasing module length to reduce the number of clicks between modules, (b) adding further video resources, and (c) adding material to contrast typical and atypical development.

When developing the materials, the goal was to section the content into bite-sized chunks that a participant could complete in 3–10 min. To reduce the number of clicks needed to move between modules, two participants suggested increasing the length of a single module while others indicating further reductions to module length. The team is airing toward content reduction when possible. Several participants noted that caregivers may need to jump on and off the site in the middle of a content module and inquired as to how they would navigate back to the last content they viewed if they had to exit unexpectedly. The site is designed to return a user to exact page that they last viewed so there is no extra time or navigation required to find their place again even midway through an active module. Participants reported positive feedback about this feature and may support user engagement allowing module length to vary.

Participants also provided positive feedback about the video examples. Some reported satisfaction with the amount of video and others requested further examples especially when a specific strategy or technical language was being explained. Therefore, we plan to build out additional optional video examples and then monitor which videos and how frequently videos are accessed across participants in the pilot trial to better understand the needs and preferences of a broader sample of participants.

An additional request was to provide more information about the age at which core child skills (engagement, regulation, play, social communication) would come online in typical early childhood development with video examples. Although this material may be viewed as informative and supportive for some participants, considering those who may be relatively new to their journey with autism and/or developmental delays, direct comparison to typically developing young children may be unwanted and even distressing. Therefore, the team plans to offer optional content and resources about typical development to make this information available to participants if and when they choose to access it.

Balancing the Provision of Participant Choice and Program Direction

A key consideration for online program design is to what degree the participants' movement through the program will be structured versus allowing the participant to engage the content in any order of their choosing. The decision to tunnel (predefine the content sequence) the program was made to emulate the in-person experience and structure of the intervention, which has been used in prior published trials both to support caregivers' strategy adoption (e.g., Kasari et al., 2014, 2015) and educators (e.g., Chang et al., 2016; Shire et al., 2017). The JASPER intervention is taught in layers starting with an orientation to the developmental domains (e.g., play skills, engagement states) and the sequence of development of skills within each of those domains, identifying individualized goals in each domain for the child, and then using that information to select materials and set up the environment before introducing the core strategies. Although one participant expressed that they would prefer no structure such that all content is available at any time (similar to a resource page), the online program is structured to follow the in-person format to allow participants to learn the content in layers. This sequence has been developed and informed by prior JASPER research trials as well as practitioner and caregiver coaching (see Figure 2, JASPER Dashboard).

Although the overall movement through the sequence of materials is tunneled, participants are provided with options for how they would like to engage with the materials. Participants appreciated when options were provided. For example, participants are provided with three ways to access the materials on each page including (a) listening to the material through audio narration, (b) reading the text of the audio, or (c) listening as they read. Across the participants, all three modes were utilized with no single modality expressed as the dominant preferred mode to access the information. For those participants who commented on reducing scrolling, it is notable that these

Figure 2. Draft JASPER program interactive roadmap.
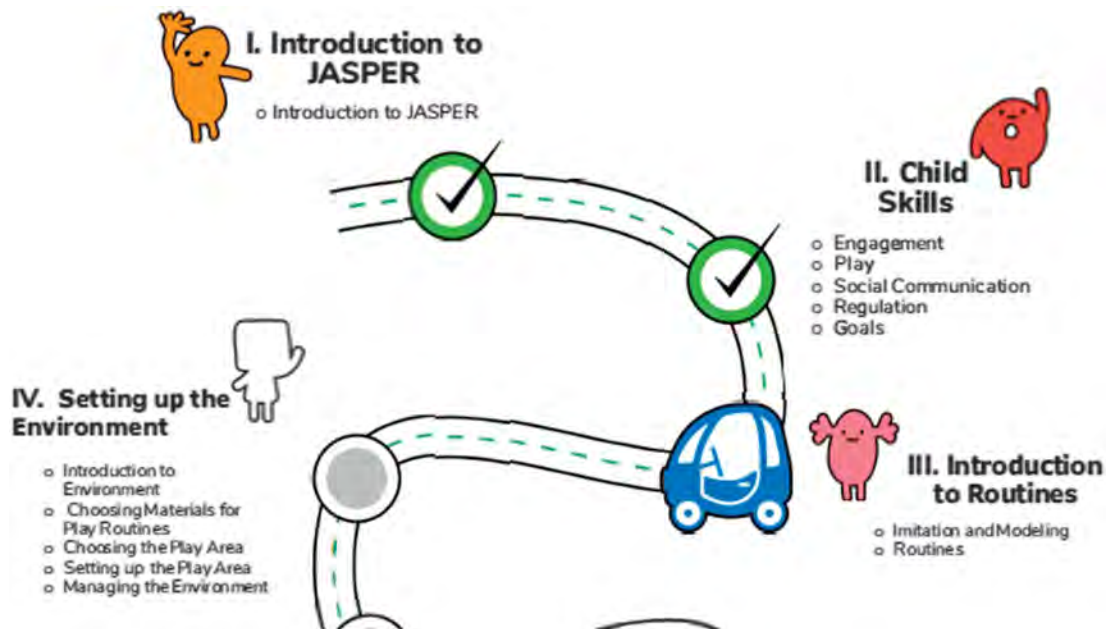
participants accessed the information by reading the commentary rather than playing the audio. One participant suggested moving the text commentary side by side with the visual rather than below to make the visual content more accessible while reading.

Balancing Program Comprehension and Progress With Individual Learning Styles

Brief multiple choice and true or false comprehension questions (framed as knowledge checks and video reviews) are included within each module for the purpose of both participant engagement/comprehension and to provide the family's interventionist with individualized information to guide discussion. Participants were positive about the format of the questions and provided feedback that presenting one to three questions at a time would generally be fine. Participants did have mixed feedback about the best placement of the questions, with some suggesting that the questions be paired closely with the target concepts and spread throughout a module, while others preferred a set of summative questions at the end of a module.

Participants also provided mixed feedback regarding how much access they wanted their interventionist to have to view their use of the online materials and their answers to the comprehension questions. Some participants reported that they would prefer their movement through the content and question answers to be private while others desired to share this with their interventionist. Furthermore, some

participants requested more opportunities to communicate their ideas, questions, and comments to their interventionist directly through open text boxes knowing the interventionist would have access to their communication. One possible solution is to make the submission of comprehension questions and communication with the interventionist via open text boxes optional. It may also be beneficial to explicitly discuss what information will be shared with the interventionist and why at the time of enrollment through an opening conversation with the interventionist. Both the personal connection to understand who will view the information and the rationale for sharing this information may support participant comfort and confidence using these features.

Summary of Program Revisions Based on the Participants' Feedback

The participants' feedback aligned well with some planned additions/modifications to the program and highlighted some novel additions. The revisions are focused on supporting user engagement in alignment with recommendations for core design features of electronic health applications including the interface aesthetic, navigation, personalization, reinforcement, communication, message presentation, and credibility (Wei et al., 2020).

Interface Aesthetic and Navigation

Participants indicated that the site aesthetics including the color scheme, characters, and graphics were

pleasing overall. Furthermore, the site was described as easy to use, but some participants desired more visual information to clarify where they were in the broader scope of the program. Usability testing participants were not able to access the participant dashboard that will include an animated roadway because this section was still in active development. The dashboard will provide a visual overview of the program. Each section of content will be represented as a stop on the roadway with a JASPER character. The sections and characters will light up in color as the participant completed a section and moves to a new portion of the program. This will highlight the content that has been completed, what is yet to come, and make for a clear path to navigate back to prior content. Furthermore, in response to the comments regarding scrolling, the team will also work with the developers to revise the page formatting to better fit the visuals and then text commentary into a page that can be viewed without scrolling.

Personalization

The child skills sections introduce the participant to sequence of development of a set of skills (e.g., play skills). Participants will have access to the full developmental sequence; however, based on the child's individual goals identified by the interventionist, the participant will be directed to across specific sections of the child skills content that best match their child's goals. For example, play is presented as a series of 16 developmental levels. The participant will be directed to two to four specific play levels that are most relevant to their child's current stage and next steps. This method provides the participant with information that is most relevant to their child with the option for the participant to view more information if they choose to.

Further personalization will be achieved through connection with an assigned interventionist for the duration of the program. The interventionist will be available to discuss the content, provide individualized support for implementation, help troubleshoot as needed, and provide supportive accountability for the participants' goals for program use.

Reinforcement and Gamification

The visual dashboard including the JASPER characters create a more game-like atmosphere for the program. A planned addition includes an animated JASPER character party (e.g., characters celebrating with party hats and confetti) that will be provided as a reward for finishing a module. This will be augmented by the visual animated dashboard noted above that will provide further gamified animation by showing progress through the movement of the car and light up color of the characters in the new section. A planned addition is the inclusion of

text reminders for engagement if the participant has not logged in within a certain window that will be individualized based on the participants' stated intentions for implementation.

Communication

The component of the program that was most widely commented on with mixed feedback was comprehension check, including multiple choice and true/false questions. We will follow the participants' feedback to keep the number of questions asked from one to three at a time. Furthermore, participants will receive an immediate explanation of the correct response after submitting a response to a comprehension question. Mixed feedback was provided on whether to have the questions placed throughout the module or only at the end of a module. The revised program will include both options across the modules, and the team will seek more feedback during pilot testing.

The team will also plan to include a discussion of how information will or will not be shared with the family's interventionist during the initial introductory meeting with the interventionist. With mixed views on what information would be shared with the interventionist, open discussion of what information will be shared and why will hopefully support participants' comfort and confidence sharing with their interventionist.

Message Presentation

The team will continue to build out the glossary of key terms to make technical language and key strategy terms as easily accessible and consistent throughout the program. The team will also continue to revise the text to reduce the length and complexity whenever possible with the aim of a sixth-grade reading level.

Following the request for additional visuals, the team will continue to build a library of optional video examples including troubleshooting for common challenges. Furthermore, an addition that was planned prior to user testing was to build further modules to explicitly support the transfer of the intervention strategies from play into other daily home activities such as book reading, mealtime, laundry, bath time, and so forth. Such activities have been included in prior in-person caregiver-mediated JASPER studies (Kasari et al., 2014) and would meet the participants' request to see the application of the strategies throughout the family's day.

Credibility

Participants did not speak to this component; however, as recommended by Wei et al. (2020), the site will be free of advertisements, each participant will have a unique log in and password, the material will share information from an evidence-based intervention, and a privacy policy will be available for participants.

Limitations and Next Steps

For each Think Aloud session, the participant was introduced to one module focused on one aspect of children's development (e.g., social communication) and one module that introduced a core JASPER strategy (e.g., establishing the base of the routine). Although this allowed the participant to view the features of specific modules in depth, it did not allow for them to explore the experience of moving through the full sequence of the content. The team will seek additional feedback on this aspect of the participants' experience through pilot testing. Furthermore, the pilot trial will engage a sample of families participating in community EI and ECSE services. While a strength of the current study is the inclusion of Asian participants who are nonnative English speakers, the pilot study will broaden representation of historically under resourced and underserved families. Feedback from this larger sample will aid in further exploration of the needs and preferences of families. Additional questions for the pilot include examination of participants' engagement with requested content including additional video examples, information about the timing of skill development in typical early childhood, as well as the use of program strategies in daily home routines beyond play with toys.

Conclusions

Usability testing highlighted both strengths and valuable suggestions for program modifications to increase the ease of navigation and message presentation for families of young children with ASD. Understanding how to present materials that are acceptable to the target users has important implications for how clinicians communicate content in self-directed materials be those online or in hard copy format (e.g., handouts, brochures). Within this sample, the variation in individual user preferences (e.g., amount of interventionist contact, preferred way to engage with the material, preference to listen, read or both, etc.) is substantial. Until larger trials can gather further data, offering participants choices for mode and method of learning when possible in clinical practice may support varied learner preferences.

In this study, users experienced only two modules without the flow and sequence of the full program. How participant understanding changes with access to the full program and how this base of knowledge translates to implementation of strategies with the children are questions of clinical importance that will be explored in the larger pilot trial. The revised full online intervention program will be piloted with the asynchronous materials combined with different types of synchronous support from an interventionist. In addition, the pilot will include a broader community of participants that will provide additional information to align the program with the needs and learning preferences of the families.

Author Contributions

Stephanie Y. Shire: Conceptualization (Lead), Funding acquisition (Lead), Methodology (Lead), Supervision (Lead), Investigation (Equal), Formal analysis (Equal), Writing – original draft (Lead). **Stacy Arbuckle:** Data curation (Supporting), Formal analysis (Supporting), Writing – original draft (Supporting). **Wenjing Bao:** Data curation (Supporting), Formal analysis (Supporting), Writing – original draft (Supporting).

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Appendix

Joint Attention, Symbolic Play, Engagement, and Regulation Strategies

Strategies	Description
Supporting Engagement and Regulation	Appropriately matches the child's pacing and modulates affect during the interaction. Applies behavioral strategies to help the child sustain engagement and regulation.
Environment	Organizes the materials and physical space to facilitate joint engagement. Provides developmentally appropriate choices within the child's reach and sight. Provides environmental structure that matches the needs of the child and supports the child's initiations. Moves as needed to stay face to face with child.
Balancing Imitation and Modeling	Immediate and consistent imitation of the child's productive play acts and initiations. Provides support by modeling when the child isn't sure what to do next.
Establishing Play Routines	Establishes a clear, developmentally appropriate sequence of steps (routine) that has a clear direction. The adult and child have equal and active roles in the play.
Expanding Play Routines	Follows the child's appropriate play expansions. Provides timely and developmentally appropriate supports to help the child add new steps to the routine as needed.
Programming for Joint Attention and Requesting	Responds to the child's spontaneous joint attention and requesting skills. The adult models developmentally appropriate nonverbal and verbal joint attention and requesting skills, and creates opportunities for requesting and joint attention.
Language Strategies	Uses primarily commenting language at the child's level, responds contingently to all communicative bids from the child, and expands the child's communication.