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Cognality VR: Exploring a Mobile VR App with Multiple Stakeholders to Reduce Meltdowns in Autistic Children

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Cognality VR: Exploring a Mobile VR App with Multiple Stakeholders to Reduce Meltdowns in Autistic Children

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Many autistic children can have difficulty communicating, understanding others, and interacting with new and unfamiliar environments. At times they may suffer from a meltdown. The major contributing factor to meltdowns is sensory overwhelm. Technological solutions have shown promise in improving the quality of life for autistic children-however little exists to manage meltdowns. In this work with stakeholders, we design and deploy a low cost, mobile VR application to provide relief during sensory discomfort. Through the analysis of surveys from 88 stakeholders from a variety of groups (i.e., autistic adults, children with autism, parents of autistic individuals, and medical practitioners), we identified three key features regarding ways to manage meltdowns: escape, distract, and wait it out. These insights were implemented in a system, then was then remotely deployed with 6 families. Findings and future steps are discussed.

CCS CONCEPTS • Human-centered computing • Human computer interaction (HCI) • HCI design and evaluation methods • Usability testing • Human-centered computing • Ubiquitous and mobile computing • Ubiquitous and mobile devices • Smartphone • Human-centered computing • Interaction design • Interaction design process and methods

Additional Keywords and Phrases: human-centered computing, usability, ubiquitous and mobile computing, participatory design, autism, meltdowns, virtual reality, mobile

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1 Introduction

Autistic people may become overwhelmed by their environment and suffer from a meltdown. The major contributing factor to meltdowns is sensory overload. Meltdowns or “having a meltdown” are episodes where a person has difficulty regulating oneself and appear as if the person is “out of control.” Meltdowns are different from tantrums which is important to stakeholders in terms of ways to reduce the likelihood of future occurrences. As one author describes it: “A tantrum is willful behavior in younger children and therefore can be shaped by rewarding desired behaviors, whereas a meltdown can occur across a lifespan and is not impacted by a

rewards system. Tantrums slowly go away as a child grows up, but meltdowns may never go away”

[1]. Meltdowns are extremely unpleasant physically and psychologically for the person experiencing them. As an autistic author on the topic of meltdowns puts it, “It was as I was being held hostage by my own mind, the more I tried to calm myself down once I escalated, the more my brain began shutting down” [5].

2 Related Work

There is a long-standing trend in CHI of assistive technologies aimed to alleviate undesired aspects of autism [4]. Some of these projects come from a rehabilitation framework aimed to teach functional or socially expected behavior. Other projects are aimed at mediating the lived experience in the social and physical world from the perspective of the autistic user. In this later type, the role of sensory experiences has become one focus. For example, early work development multisensory environments to accommodate differences in sensory adaptation [6]. Novel ways to engage the senses for autistic children has been to explore tactile systems such as a bendable fabric that creates sound [10] and virtual painting of physical surfaces [8]. Virtual spaces as a safe space for play have been explored by a number of researchers who have found the digital barrier to be a welcomed constraint [2,3,7]. One work in particular that addressed variations in sensory processing style found that virtual play across neurodiverse children can provide rich engagement [9]. To our knowledge, no efforts have been made to utilize mobile immersive technology to mitigate the effects of meltdowns in a mobile context. Therefore, we turn our gaze to those in the moment of pain due to meltdowns. We understand that meltdowns often occur outside the home, therefore we employ a mobile technology.

This project has two parts. The first study elicited experiences from a variety of stakeholders who live with or experience meltdowns and drew insight across multiple stakeholder types. The insights from the survey became the design guidelines that were implemented in a functional prototype. The second study was deployed the prototype to determine feasibility and acceptability of the system in the natural environment.

3 Study 1: Participatory Design

The aim of our survey was to a.) determine already existing coping mechanisms for meltdowns; b.) identify recurring themes and commonalities between each survey and interview participants; and c.) understand the sensation and social impact meltdowns have on families. We gathered user requirements for this project through surveys and interviews of multiple stakeholders. We posted a survey on social media sites with autism related forums (i.e., r/Autism and Autism Forums) asking about their experiences with autistic meltdowns. We received surveys from 88 people with autism or involved with an autistic person. Specifically, those surveyed were adults and children with autism or legal guardians of children with autism. The questions ranged from qualitative descriptions of meltdowns to different coping strategies and family dynamics (See A2 in the Appendix for survey questions). Survey results were analyzed using qualitative coding methods inspired by grounded theory methodology [6]. We considered the ways in which participants described their response to meltdowns to glean design considerations.

3.1 Survey Participants

For the design study, we collected input from 61% autistic people ($N=55$), 10% medical professionals ($N=9$), 27% parents of autistic children ($N=24$). See A1 in the Appendix for more demographic details. We found common patterns run across the 88 participants. Several themes emerged through our analysis. We noticed that nearly 90% of parents reported that their child experienced meltdowns on a regular basis and 70% of autistic adults self-reported regular meltdowns. This finding suggest that meltdowns are common and therefore might benefit from an application designed to mitigate meltdowns. For example, in response to the question “how do you cope with meltdowns,” Adult 9 indicated they did not have a sufficient strategy such as “I don’t. I just have to wait for it to pass”, and Adult 26 stated they “rage out until I am tired”. Child 4 explained situation-specific strategies: “If at

home, lay in bed, at school, cry in bathroom". These comments reinforced our motivation to build a system of support that directly alleviates meltdowns—wherever they may occur.

Parent and autistic adults described meltdowns as sensory overload that results in self-stimulation or "stimming". Stimming refers to unusual and repetitive body movements that allow the individual to manipulate their environment and produce stimulation. Parent 17 said they are episodes of "crying, inability to self-soothe, rocking, inability to speak, he holds his hands on his ears or he starts to stim". Adult 14 explained how sensory perceptions affect a meltdown. They stated meltdowns can be: "Scary and difficult. All sounds become a mix of a deafening noise you can't distinguish between but that your brain is still trying to filter causing them to appear louder or quieter than they are. Lights are too bright, movements get blurred, you can't understand anything that is happening. Touch is something you can't stand either. A really bad one can feel like you're going crazy. During some I felt like tearing my eyes out or stabbing my ears just to stop it. Most are not that bad, just painful. If it is prolonged, I can get a panic attack". Although each person is unique in what is triggering a meltdown and how they specifically cope, all seem to wish to not experience meltdowns. Themes around coping emerged.

To develop design guidelines for our prototype, we clustered insights from each stakeholder type into the following categories: physical escape from the environment; removing or adding sensory input (e.g., engaging in physical acts); and waiting for time to pass. Each section contains further quotes from survey participants.

3.2 Escape to Safety through Sensory Isolation

To ensure someone is safe during a meltdown, several strategies were described. For young children, parents take steps to ensure safety. Parent 7 said they "make sure he's in a safe space and give him some space for a few minutes. Adults expanded on their feelings and actions when they experience a meltdown. Adult 33 "remove[s]self from the situation, if possible". Other adults address how others respond to their experience. Adult 39 said "the people around me just basically ignore the behavior and focus on keeping me safe". Adult 20 explained their escape by stating, "I have to go somewhere neutral and calm sensory wise, and then just wait. Most of the time I feel them coming so excuse myself from the problem and go calm down first to stop them happening". Again, Adult 14 describes their reaction to the meltdown experience as efforts to escape: "Cover my eyes and ears when possible, then seek alone, quiet and dark space as soon as I can. Stay there trying to be as small as possible. You have this feeling like you're a wounded animal that needs a secure place to protect yourself. Avoid people, loud noises, lights and unsettling textures and it gets better in a few hours. For a bad meltdown, I get a fever and need to recuperate for a few days. Either silence or a quiet, relaxing music, some dim light helps the most."

Autistic adults escape by removing stimulation or removing themselves. Adult 11 by stated, "if I am able to reduce or remove whatever will cause me sensory overload, I will do that". Adult 33 said they "either remove myself from the situation if possible. If not, I tend to shut down until it is over". For Adult 5, "it depends on how bad the breakdown was and how quickly I was able to isolate myself; For me, it "usually takes between 20 mins and 2 hours". Adult 30 said they "leave the area and go someplace quiet". Adult 21 stated "once it's happening, I try to find the quietest place to ride it out". Lastly, Child 7 stated that they "usually get away from the sources of sensations as quick as possible".

3.3 Sensory Distraction provided by Others

Both cognitive and physical events were described by participants to override the meltdown. Both diverting attention or creating distraction through behavioral means were observed across stakeholders. For example, during the interview portion of our study, Parent 9 reported meltdowns were the result of having to do an unpreferred activity, specific environments, and audiovisual stimulation. One interesting anecdote that we collected was that not only does removal from the situation help mitigate meltdowns, but that certain visual and tactile cues also helped. For example, one participant reported that whenever her child encounters a meltdown on a plane, he orders coca cola because of its unique texture and color. Adult 11 told us: "I have to try to distract

myself from negative feelings, either by thinking of something else or rocking back and forth. If I am able to reduce or remove whatever will cause my sensory overload, I will do that”.

Another method of coping involved diverting attention or engaging the child cognitively. Adult 5 responded that he dealt with his meltdowns by “Talk[ing] to myself” or by “play[ing] a video game”. The types of devices and medium used to divert attention also varied depending on age. Child 6 and Adult 10 described resorting to “Music”, whereas Parent 14 employed “Pokémon cards, AC/DC thunderstruck”, and Parent 6 used “Deep breaths”. By far one of the largest categories of coping with meltdowns were through physical responses.

The main source of physical coping came from some form of pressure on the body Parent 5 reported using “hugs, deep pressure and distractions”. Parent 13 said “I hug him and wait it out”, much like Parent 4 who engaged in “hugging, light touch, counting down, singing, weighted blanket”. Parent 17 responded that she “hold[s] and rock[s] him until he can stop crying. I make hot milk with honey for him to sip and feed him or talk about what's happening”.

3.4 Self-Management Behavioral Strategies

The autistic adult group offered their self-management experiences. Adult 7 stated they engaged in “screaming, crying and kicking tend to make it go away”; Adult 27 used “Squeezing or hitting something repeatedly, rocking, hyperventilating, crying”. Adult 29 stated they “hold my breath to help create tension in my body, listen to music” and Adult 8 said they “trained myself to focus inward on what I want to accomplish in a given situation”. Waiting it out became a theme a key component of coping. Parent 9 stated when their child has a meltdown they try using “time, breathing slowly and deeply”. In many instances, waiting out the meltdown was combined with removing oneself from the triggering situation. For example, Child 5 said their strategy to a mange meltdown was to “let it burn out or just sit down and wait”. Adult 2 said they “just wait somewhere that doesn't have a lot of sensory input”. Adult 5 commented that they “Go into isolation and let time take care of it”. Parent 22 stated that they find they are “Waiting... it's just crying”. These varied techniques also come with social consequences, such as those expressed by Adult 9 when they said, “I suppose waiting to calm down is effective” he also notes that it is “really embarrassing in public situations” and that he tries to “move away from the crowds”.

3.5 Design Guidelines

The design of the system was created with the input from a variety of stakeholders. The survey responses and interviews provided themes that inform the following design guidelines: remove sensory overload; provide sensory isolation; replace with desired sensory input; make safe; avoid time constraints.

Remove Sensory Overload to Create Sensory Isolation. Remove environmental stimulation by entering virtual reality where the immersive environment can be controlled through design.

Replace Sensory Input with Desired Input or Activity. Provide options for similar types of sensory input to those sought during a meltdown. Input may involve putting one’s attention elsewhere and/or physically seeking or receiving simulated sensory input such as movement. Add or subtract or replace visual, auditory, movement(vestibular), touch and pressure (proprioception).

Make Safe. To make sure no child gets hurt while using the scenes, we decided to use cardboard headsets. These headsets have a plush inside and the cardboard material allows it to bend easily if needed. Additionally, cardboard headsets fold into a compact shape, which means they are easily portable. This is essential in this research since the participants can travel and use the scenes at whatever time they choose. These headsets are also specially designed to work only with mobile devices, which makes it accessible to a lot more people than other VR headsets that only work with computers. Even though for the purpose of this research we are providing participants with their own headsets, if people are inclined to try out the scenes for themselves in the future, the headsets are very affordable.

Avoid Demands and Time Constraints. We aim to create a timeless experience without the need to respond or act upon any stimuli in virtual reality.

With these design insights in mind, we move into implementation and deployment of a low cost, highly mobile, web-based virtual reality (VR) app for people who experience meltdowns

4 Study 2 Mobile VR System Development

After reviewing the repetition of statements regarding isolation from one's current environment, we decided to create calming nature scenes. Initially, scenes were created to look very realistic. They had no sounds and/or animations as we aimed for the designs to be relaxing environments for children. The scenes offer a combination of photo-realistic and low-poly objects to create options for users. Additionally, we considered how participants described specific sensory input. These inputs included: Non-Physical/reliance on something else, providing sensory input to ease need for sensory output, Physical Actions (hitting, rocking, stimming). We grouped these themes into sensory input/out features where we could add or subtract or replace visual, auditory, movement(vestibular), touch and pressure (proprioception). Given that several design participants described the phenomena of waiting it out or doing nothing, we considered the role of time in this experience. In considering how to capture this need in our design, we concluded that there should be no time pressure or time limit to a support system.

4.1 Virtual Underwater Environment

This scene provides distraction, exploration, animation, and sound via a low poly environment that allows for rapid rendering and minimal detail. The underwater scene was created because many people in our survey indicated that to deal with meltdowns, they engaged in changing to more peaceful scenery and occasionally, it was mentioned people engaged in some form of touch such as hugging or squeezing (see Results section above). This scene includes an animation of a fish and an orca whale swimming around to make it more interactive and "game like". It is also equipped with optional sound which further enhances relaxation. Although the mobile VR system does not provide touch functionality, the illusion of being underwater could provide some semblance of deep pressure on the body.

4.2 Virtual Forrest Environment

We created a nature scene since our research indicated that nature helps many people feel relaxed. This scene was also the easiest prototype to build. Initially, the forest was created to look very realistic with no sounds and/or animations. After having tested the system with acquaintances, most of the feedback was that the scene made many people dizzy because of constant lagging and that they would like it to be more interactive. We took all of this into consideration and decided to make the animation low poly, which made it look less realistic, but it stopped any lagging from occurring. We also added an animation of a bird flying around the trees and constant calming nature sounds of birds chirping, wind, and the rustling of trees.

4.3 Virtual Bedroom Environment

Our research indicated that the bedroom was one of the most calming places for neuro diverse individuals. Thus, we rendered a virtual bedroom that anyone could feel safe in. We created two versions of the bedroom: a dark bedroom and a bright bedroom. These rooms have no animations or sounds, but they are one of our more realistic scenes. There are currently no sounds embedded in the scene to leave it as a quiet space.

4.4 Virtual Train Environment

Our one-on-one interviews indicated that many children with autism really like trains and train sounds because it distracts them from their surroundings. Hence, we created a train ride scene where the user is sitting inside a moving animated train. The scene provides the user a ride from inside a train car. Landscape scenery is visible from the windows and movement within the car is possible. The illusion of movement in VR is intended

to provide movement and is intended to provide stimuli to emulate vestibular input, often reported as a sensation that participants sought during meltdowns (e.g., rocking). The scene does not currently have any sound, but we are working in implementing it as soon as possible. This animation is low poly because we wanted to make sure that the animation didn't lag and made anyone dizzy.

These elements were implemented through a web VR platform affords mobility and is inexpensive (if one has access to a mobile phone). After having tested an early version, most of the feedback was that the scene made many people dizzy because of constant lagging and that they would like it to have sounds and animations. We took all of this into consideration and decided to make the animation low poly, which made it look less realistic, but it stopped any lagging from occurring. Pixels needed to be graded to reduce dizziness. Our serving platform selection criteria was very simple: the platform needed to be portable and accessible anywhere; less than a minute required from detection of meltdown-behaviors to a ready scene; and the right match between comfort and durability. The cardboard headset is durable enough for safe use, portable, and allows for use of a web-based API (i.e., WebXR APIs and A-Frame). We also provided an inexpensive plastic headset as well.

5 Study 2 Deployment

The deployment consisted of trying out the system at the families' will in their natural environment for 4 weeks. Given this work occurred during the first few months of COVID-19 pandemic in the USA, lab visits were not permitted, therefore all research activities occurred virtually. Parent consent and child assent was obtained via email and cardboard and light plastic headsets were mailed to their homes. A login code and link to the website was provided as well as video instructions for logging on. The stated goal of the pilot study was to try the system in a natural environment when it seemed helpful. The lead PI or research assistants emailed families weekly for troubleshooting and four weekly surveys that contained statements for the participant to respond to. Choices ranged from "strongly disagree" to "strongly agree" on a five-point Likert scale. Exit interviews were conducted for 2 participants who responded to that request. Each family received a \$100 e-gift card from Amazon. Six families of children with autism returned signed consents and assent forms in response to recruitment fliers distributed via email to our professional and personal networks. See Appendix C for [Table 4](#) of demographic details.

6 Results

Results from the deployment surveys and interviews provided evidence of acceptance as well as areas to improve. Overall, survey results indicated a positive response to future use. In response to the statement, "I would want my child to use the system frequently," most parents agreed. Specifically, we found that a third of the parents selected "strongly agreed", a third "agreed", one was "neutral" and one "disagreed". However, the context for this frequent use was not necessarily to manage meltdowns. For example, when asked to rate the statement, "I would want my child to use the system to prevent a meltdown", two strongly agreed, one agreed, one somewhat disagreed, one disagreed, and one strongly disagreed. In the follow up interview with Parent 3 who strongly disagreed, he indicated his son's applied behavior analysis therapist said he is not allowed to use a calming mechanism to calm a meltdown. Confusion over a meltdown and tantrum persist even in clinical staff.

Most parents found the system fairly easy to use as evidenced by their respond to the question, "how complex did they find the system half reported it was "not at all complex", and the other three reported "somewhat complex". However, once in the system, most found it easy to use. In terms of using the system they found it easy as four of the six found it "easy to use", one that at "somewhat easy" and one found it "not at all easy". When asked about navigating the system, half found it easy to use two found it moderately easy and one found it difficult. And when asked if they thought there was too much inconsistency in the system five disagreed and one was neutral.

In terms of the learning to use the system, we asked how quickly or slowly they learn to use it, four learned quickly and one reported they learned it slowly. We also wanted to know who engaged with the system, so we asked who set up the app. It was the parent for five cases, and one parent reported it was the child. In terms of the

impact on the child's life the system, half of the parents found it helpful, one was neutral, two found it not helpful (Parent 3 and Parent 6). Parent 6 description of use case with her non-verbal son using the system from start to finish as she explains, "At first was a bit challenging because the iPhone6 plus® was too big to place in the black VR device probably because it was in an Otterbox® case. And my iPhoneXPlus® fits but I had to take out of the case. He chose the train scene, but I think he was expecting a train ride and not just looking inside a train cart. So, he was really not interested for long. I encourage him to try it and take a peek but at the end...he was indifferent to it. We switched to the cardboard device, and he chose the underwater sea scene and seem to engage in it longer than he did with the train scene and just left it next to him to watch when he pleased. But to honest was randomly checking in with him and prompting him to look in it. I probably should say he's usually on the iPad® a lot more than usual since not physically attending school and I randomly have him stop with iPad® to do some schoolwork a little at a time. Today I used another iPhone device (iPhone7® with a case) and put in the cardboard device and he again chose underwater sea scene and watch a bit but really not interested. Again, placed next to him and prompted him once in awhile to look. But he would look for like 5sec and put down. Then the iPhone7® would run out of power. And I would have to go get it charged"

It seems the children had access to a variety of technologies and digital stimulation such that this basic prototype may not have been engaging enough. For example, Parent 3 stated, his son "has some meltdowns, he doesn't like a lot of people talking to him all at one time. In retrospect, I should've used the system for meltdowns as a "sensory escape". When he gets overwhelmed, he goes to the piano and plays Beethoven's 5th". It was the intention for the system to be used as a "sensory escape" as a low demand, to create a virtual safe place—ideally, when none was otherwise readily available. Given that families were at largely at home due to COVID-19, this need was possibly met. We imagined being in the same space together for extended times might still create a need to have a virtual safe place. However, this intention may not have been clear what the purpose of the system was as we left the details up to families to explore. And they did explore some. We found that parents reported they directed most if not all the access to the system. The survey results revealed that predominately parents initiated the use of the system. Three parents reported they initiated use 100% of the time; one parent initiated 99% of the time; and two parents initiated 80% of the time. When asked, "how much did they use the system," three reported weekly; two reported daily; and one every 2 to 3 days. When asked, "How much time did they use it," for parents ranged in their report from 30 seconds to 20 minutes. Lastly, when asked if they would you recommend the app to anyone else, half said yes, one said maybe in one said no (Parent 6). In the follow up interviews we learned the children liked it. Parent 3 said his son liked that there was no cable in the headset so the child could move around. However, Parent 3 added he would not use it to calm a meltdown as according to his Applied Behavior Analyst over when and how to use the system seem to be an undercurrent of this remote study. We also learned that onboarding remotely was a significant challenge for most participants. Getting started remotely seemed to be difficult for the participants we interviewed. Foremost, having a smart phone available that fit into at least one of the 2 headsets was an unforeseen requirement. Lastly, another issue was maintaining VR mode on the phone (staying in the app) while in the headset. It seemed for some families the app closed once in the headset. Parent 3 suggested Automatically turn on the do not disturb system. These onboarding issues could have been easily determined had the orientation to the system been held live or in person. Lastly, Parent 3 made suggestion where a system like this would be most useful, during non-COVID times. He stated that system would be most useful use the while waiting at a doctor's office or generally waiting, at church, and riding in the car.

7 Discussion and Conclusion

The present work aimed to provide mobility and flexibility for reducing meltdowns through web-based VR. We considered the coping strategies by multiple stakeholders: autistic adults, children with autism, and legal guardians of children with autism. We implemented the design guidelines we drew from their reported experiences regarding preventing and managing meltdowns. For example, the need to "make safe" was a common theme across stakeholders. We addressed the discrepancies in the stakeholders' varying needs—i.e., to distract, to

isolate, to move, to remain still, to engage-- by providing various options of virtual environments to meet these needs. Through this process we were able to find common ground for design features. We believe common ground is important because although the end-user--the person experiencing a meltdown-- is ultimately our primary design interest, at times the end user may not always have the agency to access the technology-- especially if they are a child. Therefore, we need to appeal to those who can access and who can approve tech use. Given that some agencies are relegated to parents, it is important for them to find utility in this app. Future user studies with the app will need to determine if these design implications are helpful.

A timely benefit of this design is its mobility in that people can easily use and test it at home and use it in public. We suspect that due to the COVID-19 pandemic, families were more overwhelmed in new ways due to the COVID-19 pandemic. While every member is at home, space is limited. These neurodiverse individuals may find themselves stuck in uncomfortable situations at home with nowhere to go. The scenes we have created could be a step toward addressing this new constraint. The low cost, flexible, and mobile nature of this application aimed to meet an often-unspoken need for people experiencing meltdowns.

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A APPENDICES

A-1 Table 1: Participant Demographics.

Table 1: Parent Demographics

Participant ID	Age of Child	Gender of Child as Identified by Parent
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Parent 1	2	Male
Parent 2	2	Male
Parent 3	3	Unknown
Parent 4	3	Unknown
Parent 5	4	Male
Parent 6	4	Unknown
Parent 7	4	Male
Parent 8	6	Male
Parent 9	6	Male
Parent 10	6	Unknown
Parent 11	7	Male
Parent 12	7	Unknown
Parent 13	7	Male
Parent 14	8	Unknown
Parent 15	9	Unknown
Parent 16	10	Male
Parent 17	10	Male
Parent 18	10	Male
Parent 19	10	Unknown
Parent 20	12	Male
Parent 21	15	Male
Parent 22	15	Unknown
Parent 23	16	Male
Parent 24	18	Unknown

Table 2: Child Demographics

Participant ID	Age
Child 1	12
Child 2	13
Child 3	14
Child 4	14
Child 5	15
Child 6	15
Child 7	16
Child 8	16
Child 9	16
Child 10	17
Child 11	17

Table 3: Autistic Adult Demographics

Participant ID	Age
Adult 1	18
Adult 2	18
Adult 3	18

Adult 4	18
Adult 5	18
Adult 6	19
Adult 7	19
Adult 8	19
Adult 9	19
Adult 10	19
Adult 11	19
Adult 12	20
Adult 13	21
Adult 14	21
Adult 15	21
Adult 16	22
Adult 17	22
Adult 18	22
Adult 19	23
Adult 20	23
Adult 21	24
Adult 22	24
Adult 23	25
Adult 24	25
Adult 25	25
Adult 26	26
Adult 27	26
Adult 28	27
Adult 29	27
Adult 30	27
Adult 31	28
Adult 32	30
Adult 33	31
Adult 34	33
Adult 35	33
Adult 36	36
Adult 37	36
Adult 38	37
Adult 39	38
Adult 40	38
Adult 41	38
Adult 42	43
Adult 43	44
Adult 44	Unknown

A2 Design Study Survey Questions

- How old is your child?
- Does your child have autistic meltdowns?
- What usually triggers your child's meltdowns?
- How often does your child have a meltdown?
- What does a typical meltdown look like?
- What are ways you help your child calm down? Is this effective and how long does it take?

- Do you believe that there are ways to prevent meltdowns? If so, which ways do you use or know about?
- What are some frustrations you experience with your autistic child?
- How does your child usually get entertained?
- What type of apps does your child use on their phone/tablet?
- Have you ever heard of virtual reality?
- Has your child ever experienced virtual reality?
- Is your child usually claustrophobic or afraid of small spaces?
- How long before a meltdown can you notice one?

A3 Table of Deployment Participant Demographics

Table 4: Demographic of Deployment Participants

Participant ID	Contact Person	Child's gender	And Child's age
1	Mother	Female	9
2	Mother	Male	11
3	Father	Male	6
4	Mother	Female	21
5	Father	Female	9
6	Mother	Male	11