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INTERACTION WITH A LARGE SIZED AUGMENTED STRING INSTRUMENT INTENDED FOR A PUBLIC SETTING

Jimmie Paloranta, Anders Lundström, Ludvig Elblaus, Roberto Bresin, Emma Frid
KTH Royal Institute of Technology
{jimmiep, andelund, elblaus, roberto, emmafrid}@kth.se

ABSTRACT

In this paper we present a study of the interaction with a large sized string instrument intended for a large installation in a museum, with focus on encouraging creativity, learning, and providing engaging user experiences. In the study, nine participants were video recorded while interacting with the string on their own, followed by an interview focusing on their experiences, creativity, and the functionality of the string. In line with previous research, our results highlight the importance of designing for different levels of engagement (exploration, experimentation, challenge). However, results additionally show that these levels need to consider the users age and musical background as these profoundly affect the way the user plays with and experiences the string.

1. INTRODUCTION

When designing interactive installations in public settings such as museums and art galleries, designers face new challenges, considering the wide variety of possible users, the impact of the surrounding environment and the durability and reliability necessary for long-term (and sometimes unexpected) user interaction.

In this paper, we present a study of a large sized augmented string instrument, with focus on how the participants approach the string and how it can encourage creativity and provide an engaging user experience. The instrument, as presented here, acts as a formative prototype for a future museum installation at the new Scenkonstmuseet that opens in 2017, in Stockholm, Sweden. The final installation will be called LjudSkogen/Sound Forest and consist of 5 similar strings in a dedicated room. The string metaphor was chosen for its affordances and familiarity, with the aim of making it as intuitive as possible [1] so that anyone, regardless of musical background should be able to play and be creative with the instrument.

2. BACKGROUND AND THEORY

2.1 Interactive Installations in Public Settings

Several comprehensive studies have looked at interactive exhibits from the perspectives of engagement and learning [1–5]. A general conclusion in these studies is the importance of rewarding both initial and prolonged engagements with an installation [1], where the experience of initial interaction is crucial as it often determines whether the visitor will continue to interact with the installation or not [5]. After this initial phase, the complexity should be increased for prolonged engagement with the exhibit [2]. This can for example be achieved by offering new opportunities and challenges for exploration and experimentation. Otherwise, visitors tend to leave the exhibit once they have figured out how the system works [3].

While kids and families form the main part of museum visitors [6], studies have highlighted the challenges of designing for the broad target group that installations in public settings typically aim for. For instance, Taxen et al. [7] noted that people have very different approaches when interacting with installations and highlighted the importance of accounting for these approaches when designing exhibits. Due to this irreducible complexity [2], iteration and evaluation with people throughout the development process is key when designing for these settings [8], as the full complexity of an exhibits interactive features can be seen only through the eyes of the visitors, no matter how experienced the designers are. A study by Campos et al. [4] also mentions the challenge that arises when an interactive installation is finally deployed, as many aspects are impossible to model or test by means of early prototypes (like the surrounding environment's impact on the experience).

2.2 Interactive Augmented Strings

Within the field of augmented instruments, much work has been done on string instruments like guitars, violins and pianos [9–16] with particular interest in sensing gestures or position of a player's fingers on the instrument. Most previous approaches to this have been based on image analysis, as noted by Guauas et al. [12] who in their study instead proposed a method of capacitive sensing. While this method successfully managed to capture gestures and touch, as shown in similar studies by McPherson et al. [13] and Tobise and Takegawa [16], it has been less successful for position measuring due to body impedance causing too much interference with the system [9]. In another study by McPherson et al. [14], optic sensors were used to accurately measure the height position of a pressed key on a piano, while Newton and Marshall [15] used infrared sensors to detect strumming motions on an augmented guitar.

2.3 User Experience

In his book Art as Experience [17], pragmatic philosopher John Dewey defined experience as constant and something that occurs continually, as we are always in the process of living. Dewey discusses the definition of an "aesthetic experience" and experiences in the world of the arts, arguing that every prosaic experience can be of aesthetic quality, since all experiences can be rich and fulfilling.

Building on Deweys pragmatic approach to experience, Wright and McCarthy provide a framework for analysing experiences in their book Technology As Experience [18]. The framework consists of four intertwined "threads of experience" and is accompanied by six non-linear sense-making processes. While the four threads outline the compositional, emotional, sensual and spatio-temporal elements of an experience, the sense-making processes (anticipating, connecting, interpreting, reflecting, appropriating, recounting) are of more interest to this study as they dwell deeper into the personal traits of the user during an experience and are therefore more evaluable from a user experience perspective.

- Anticipating: refers to the expectations, possibilities and ways of making sense that we bring prior to the event of the experience.
- Connecting: refers to the immediate, pre-conceptual and pre-linguistic sense or feeling of a situation encountered.
- Interpreting: refers to the discerning of the narrative structure and possibilities of the unfolding experience, what has happened and what is likely to happen.
- Reflecting: refers to the judgments made about the experience as it unfolds, which happens at the same time as interpreting.
- Appropriating: refers to relating the experience to our own sense of self, in context to our personal history and future.
- Recounting: refers to telling the experience to others or ourselves, which gives us the opportunity to find new possibilities and meanings in it.

2.4 Creativity

Creativity is a big part of experience, both in the views of philosophers and researchers. Apart from Dewey, pragmatic philosopher Mikhail Bakhtin also inspired Wright and McCarthys work in Technology as Experience. Bakhtin believed "that to live is to create", and that the act we describe as creative is just extensions of the sorts of activity we perform all the time [19], which can be reflected in Wright and McCarthys views that "in an open world, all action is creative, a fresh use of intelligence producing something surprising and new every time" [13].

According to psychologist Robert Sternberg, most investigators within the scientific field would agree on the general definition of creativity as "the process of producing something that is both original and worthwhile" [20], but what is "worthwhile" is a highly subjective notion and therefore also complicates evaluation. Within psychology however, divergent thinking (exploring many possible solutions to a set problem) is often seen as correlated with creativity. For instance, educational psychologist Frank E Williams [21] has used it as a measure of creativity. Drawing from the foundations of divergent thinking, Williams created a model of eight different creative skills that were used to learn and measure creativity among students, called Williams Taxonomy [21]. The skills were *fluency* (the ability to generate many ideas so that there is an increase of possible solutions), *flexibility* (the ability to produce different categories of ideas), *elaboration* (the ability to add on an idea), *originality* (the ability to create unique ideas), *complexity* (the ability to conceptualize multifaceted ideas), *risk-taking* (the willingness to be daring and try new things), *imagination* (the ability to dream up new ideas) and *curiosity* (the trait of exhibiting probing behaviours, asking, searching and wanting to know more about something).

3. METHOD

To investigate how presumptive visitors might interact with and perceive a large string augmented instrument we developed a first interactive prototype and let nine participants (see Table 1) with different background interact with the prototype on their own. The participants were not given any specific instructions regarding how to interact with the prototype. The participants represented different groups of the museums envisioned target audience: children, parents and young adults with musical interest. Three children in the ages of 9-11 (C1-C3), four young adults in the ages of 23-29 (Y4-Y7) and two parents, both 53 years old (P8-P9), participated in the experiment. The children were all male, while half of the young adults and parents were female and male, respectively.

The procedure of the user tests was as follows: first, a brief interview was held to gather information about the participants experience of music and museums. Then, the participant was left alone with the string in a lab room. No prior explanation of how the string would react to interaction was given, participants were only told that the string would be a part of a music installation at Scenkonstmuseet. The participants were told that they were free to play around and explore the string for as long as they wanted. To increase the probability of capturing their thoughts and considerations in action they were encouraged to think aloud during the interaction with the string. Lastly, semi-structured interviews were conducted in three parts. The first part dealt with the different processes of the users experience (anticipating, connecting, interpreting, reflecting, appropriating and recounting), based on the framework provided by Wright and McCarthy [18]. The second

User	*Age*	*Gender*	*Musical Background*
C1	9	Male	No previous experience
C2	10	Male	Guitar, one semester
C3	11	Male	No previous experience
Y4	23	Male	Drums, 4 years when younger
Y5	24	Female	Piano, 4 years when younger
Y6	27	Male	Piano, 9 years
Y7	28	Female	Piano and violin, 21 years
P8	53	Male	No previous experience
P9	53	Female	Piano and Guitar, 4 years when younger

Table 1. Participants in the user test.

part was based on Williams Taxonomy [21] and dealt with the creative skills displayed by the users (fluency, flexibility, elaboration, originality, complexity, risk-taking, imagination and curiosity) during interaction. The last part focused on the functionality of the prototype and the string's material. The questions were first written for adults and then reformulated using simpler vocabulary in order to be more suitable for the children (for example, the question Did you feel like you could create something original? was changed to Did you feel like you could create something new?).

The participants interaction with the string and the interviews were video recorded. The interviews were then thematically analysed for common, reoccurring themes. These themes where then used for further video analysis of what actually seemed to occur during the interaction, with focus on the processes of the users experiences and the creative skills displayed.

4. THE AUGMENTED STRING PROTOTYPE

The augmented string instrument prototype consisted of a plastic, 14mm thick, optic fiber cable that was strung to a wooden structure (see Figure 1). Pure Data was used to process data and synthesize sounds based on incoming sensor data from an Arduino and a piezo element connected to a sound card. The sensors connected to the Arduino were an analogue 3-axis accelerometer (ADXL335) for measuring string displacement (placed on the top of the cable) and an ultrasonic rangefinder (LV-EZ4) for measuring the vertical position of the users' hand (placed next to the cable on the wooden structure, facing the floor). The 20 mm piezo element (7BB-20-6) was placed on the top of the cable to detect attack and velocity.

By striking or pulling and then releasing the string with a force above a certain threshold, the piezo element detected an "attack" on the string. Attacks were used to trigger a note. The volume, attack- and release time of the note depended on the force registered by the piezo element. The note sustain until the string had stopped vibrating, after about 300 ms. The accelerometer was used to sense changes in velocity along its axes due to slight displacement of the string, cause by either touching or shaking the string. Such actions caused the system to slowly fade in the previously played note with a volume depending on the level of the velocity. Keeping the velocity above a certain threshold (by for example continuously shaking or pulling the string) without triggering an attack on the piezo activated a wah-wah filter that increased in intensity the longer the velocity was above the threshold. If an attack was registered during these motions, the wah-wah filter was turned off.

At the moment of the attack, the distance from the top of the string to the hand (or other body parts closer to the sensor) was registered using the ultrasonic sensor. This distance was used to determine the pitch of the note on a major scale, spanning 3 octaves. The higher up the hand was placed on the string, the higher the pitch of the note. The force registered at the moment of the attack controlled three different types of sounds, each being an octave apart and with different characteristics. A small force triggered a low octave bass sound, a medium force triggered a middle octave clean sound and a stronger force triggered a higher octave chorus sound. If displaced sufficiently, the accelerometer could sense in which direction the string was moving, which for the low and the high sound was used to control a band pass filter. The frequency of the band pass filter was controlled by the direction of the angle of the vibrating string (0-360 degrees). A larger angle shifted the center frequency of the band pass filter towards a higher value. This effect was quite subtle due to the tightness of the string (especially at the point where the string was attached to a wooden frame), but provided a sweeping effect to the sound due to the string vibrating back and forth (between for example 0 and 180 degrees). This effect could also be achieved by dragging the string in a circle motion.

4.1 Limitations

There are several limitations of the tested prototype. The optic fiber cable prevented the use of sensors covering the string, as they would obstruct the emitted light. A crucial design challenge in this context was to sense the vertical hand position without using capacitive sensing or frequency detection of the strung string (the latter would be difficult since the plastic string vibrated with a very low frequency). Based on the above mentioned constraints, we opted for an ultrasonic sensor. Ultrasonic sound was chosen over infrared light for its longer range and to prevent instability due to changing light conditions at the museum exhibit. Unfortunately, the selected sensor turned out to be both inaccurate and unreliable in the interaction.

A future version of the string, to be deployed in early 2017, will include a LED light intertwined fiber optic cable with DMX controller, and a haptic floor which will be realized by placing a vibrating plate below each string. The vibrating plate will be activated through interaction with the string itself.

User	*Time*	*Pluck*	*Pull*	*Stroke*	*Shake*	*Strike (Finger)*	*Strike (Hand)*	*Mute*	*Flick*	*Box*	*Hold*	*Twist*	*Drag*
C1	2:00	•			•		∆	•					
C2	4:50				∆		∆	•		•		•	•
C3	5:00				∆		∆			•		•	
Y4	3:00	•	∆		∆	•		•					•
Y5	7:30	∆	∆		•	•	•	•					•
Y6	6:30	∆	•	•		∆		•	•		•		
Y7	7:50	•	∆	•	∆	•	∆	•			•		
P8	5:40	∆	•	∆	•	∆	∆	•	∆				
P9	4:00	∆	∆	•	•	∆		•			•		

Table 2. The participants' interactions with the prototype during the user tests. Participants' main modes of interaction are marked as triangles.

Figure 1. The augmented string instrument prototype. The optic fibre cable was not lit up during user tests.

5. RESULTS

We could identify a number of actions performed by our participants through analysis of the video material capturing the participant's interactions with the string, including: plucking, striking, shaking muting, flicking, boxing, holding, twisting, and dragging (see Table 2). We define these interaction types as follows. "Plucking" is defined as pulling and releasing the string with two or less fingers, while Pulling is defined as pulling and releasing the string with three or more fingers. "Muting" the string is holding the string to cancel its motion, while "holding" is defined as holding the string still and then releasing it. "Twisting" the string is turning the string around its own axis, and 'dragging" the string is pulling out the string without releasing it.

5.1 Modes of Interaction

All participants except the children initiated their interaction by plucking or pulling the string and maintained one of those interactions as their main mode of interaction. Two of the children, C1 and C3, initiated their interaction by plucking and poking respectively, but only once before moving on to other types of interactions, as opposed to C2 who immediately started shaking the string. The children were overall quicker when it came to starting hitting the string than the rest of the participants. They also struck with their hand rather than striking with their fingers (unlike the young adults and parents who did both). The children also used less variety in their way of interacting with the string, but instead they interacted in different ways than the other participants (e.g. boxing, twisting, heavy shaking and even hitting the string with their head). All children had shaking and striking with the hand as their main modes of interaction, while the young adults and parents mainly plucked, pulled or struck with their fingers on the string. All users except for C3 tried muting the string. Rare modes of interaction among the young adults and parents were flicking the string (done by Y6 and P8), stroking the string (done by Y6, Y7, P8 and P9), dragging the string (done by Y4, Y5 and also C2) and holding/releasing the string (done by Y6, Y7 and P9). It is also worth noting that none of the children pulled the string. See Table 2 for a more detailed overview of modes of interaction.

5.2 Concepts of the Instrument

The string metaphor was perceived differently among the participants. Users with previous experience of musical instruments (see Table 1) understood it as though the string would produce a sound when you touched it, while the rest of the participants instead believed it would start glowing (an expectation Y4 and Y5 also had). Almost half of the participants (C2, C3, Y5, P8) thought of a rope or a lace instead of a string when they first saw it. After the initial interaction, some of the participants tried to produce different pitches by interacting at different heights of the string. Participants C3, Y5, Y6 and Y7 believed that the string would react like a piano or guitar with low pitch at the bottom and a high pitch at the top. The other participants instead discovered this property throughout the experiment, except for C1 who never found this property, and C2 who thought the pitch varied depending on the direction from which the string was hit. Y4 and Y5 felt that they could control the volume of the sound depending on the force they applied when striking the string, while Y7 expected it to be like that but did not feel the system responded in that way. Y5, Y6, Y7 and P8 were also curious whether the direction from which they hit the string had any effect on the sound.

The different types of sounds were noticed by all users, while this was not an expected behavior, many (C3, Y4, Y5, P8, P9) thought that it was exciting that there was more to discover. None of the users figured out how to control this aspect on their own and Y6 and Y7 expressed that this was confusing. Y7 also felt that triggering different sounds depending on the force caused the individual sounds to lack dynamics as it decreased the potential to adjust the volume. However, Y7 still found the potential of triggering different sounds interesting.

Y6 and Y7s perception of the instrument's complexity also differed from the rest. They felt that the instrument was very complex, with Y6 expressing that "it's usually easy to understand the concept of a new instrument", while the other participants perceived the instrument as "easy" because "you just need to touch it to make sounds".

The wah-wah filter was an appreciated element in the instrument as C1, P8 and P9 all uttered "Cool!" when they discovered it. Y7 also expressed that "this feels like I can control". Both C2 and Y4 also seemed to be in control of it, dragging it back and forth or shaking it several times, controlling the intensity of the filter. Y4, Y6 and P8 expressed the desire to be able to play more than one note or sound simultaneously on the string, in order to be able to play harmonies and not just a melody, or to be more than one person playing it. For that reason, C1, C2, C3, Y4, Y5 and P8 also wanted to have more strings, similarly to e.g. a harp.

5.3 Phases of Experience

overall, the participants expressed curiosity and excitement in the initial phase of the experience. Some (Y4, P8, P9) laughed for themselves while interacting with the string and others (Y1, Y3, Y4, P8, P9) uttered sentences like "this was cool" or "fun". Y5 and Y6 explicitly noted that the string was "very conspicuous, you just want to touch it".

After making the string produce sounds, the way of interacting with the string differed substantially between the children and the other participants. The children were noticeably intense in their interaction, using fast and energetic movements without much time for pauses or apparent reflections. The young adults and parents instead seemed more thoughtful and thorough in their approach, taking their time to reflect on their interactions and covered most of the more expected ways of interaction (as seen in Table 2). The children were mainly concerned with creating and discovering sounds. While C3 wanted to continue playing after the interview, C2 felt stated that "it was fun in the beginning, but then you got tired of doing the same thing all the time".

The adults (and C2) all tried but failed to control the string in order to successfully play a song or a melody. Y4 said that the pitch "felt random" and Y7 believed she was activating a predetermined loop. Y7 was particularly frustrated as her initial hopes to "become friends" with the string turned out to be difficult and she instead started to wonder whether "she was stupid or the string was stupid". Y6 also became irritated as "the string decided what note to play" and expressed weariness due to lack of control. In contrast, Y4, Y5, P8 and P9 all enjoyed playing the string and thought it was fun despite the unexpected lack of control. Although Y4 felt that the pitch was random he felt that "its cool that you can do so much with something as simple as touching a thing". Instead of blaming the instrument for lack of control, Y5, P8 and P9 expressed that if they had only been more musical they could probably have played it. P8 also felt that "it doesn't need to be so serious" in response to playing a melody, and that "its just cool to play around, even if you dont have control". P9 also said that the initial drive to just "play" soon evolved into a desire to play a song. For Y5, Y7 and P9 this became a problem that they wanted to solve, while Y7 got frustrated and desired a shorter "learning curve". In opposition, P9 felt that if it had been easier to play a melody she would have been "finished" with the installation quicker.

5.4 Interaction strategies

As seen in Table 2, the participants had several different ideas of interacting with the string. It was hard for the users to build further on these initial ideas of interaction due to the lack of control. Y7, for example, expressed that "Its hard to be creative when you dont have control over what notes you are playing" and that the string "lacked consistency". As mentioned previously, children showed less variation in their interaction than the adults, but instead interacted in different ways than the others.

As mentioned earlier, children were more intense and seemed less "careful in their interaction, hitting and shaking the string with more power compared to the other participants. Some young adults (Y4, Y7) felt that they dared to hit harder and interact in ways they probably wouldnt have with other string instruments. Y5 said it felt easier to hit and pull this string than other instruments, as "theres norms and rules for traditional instruments that dont exist for this one. However, some (Y5, Y7 and P8) did not dare to pull it out too much or shake it too hard in fear of destroying the instrument.

While most participants stated that they were too focused on finding out how the string worked to think about anything else, the installation triggered the imagination of some users, like those suggesting using more strings so that they could play the instrument like a harp. One user also said that she felt like playing the string as an upright bass, or to have the string horizontally and play it like a piano.

6. DISCUSSION

The study was designed to investigate interaction with a large sized string instrument in a public setting. Although the prototype of the augmented string did not provide the reliability that was initially aimed for and affected the way users interacted with the string (in terms of what the users could control for as well as the user's expectations), the results still provide relevant insights into string interaction for museum settings.

The results support the ideas of layering the experience and allowing for different levels of engagement, as shown in previous studies [1–3, 5]. An augmented instrument in a public setting gives rise to particular design challenges; one needs to consider the age and musical background of the potential users, since these factors might affect both the interaction as well as the user's expectations. Depending on whom the experience will be designed for in first hand and what level of engagement that is desired for the particular exhibition, certain compromises regarding the instruments functionality might have to be done.

For initial engagement, an early success experience is crucial for maintaining interest in the exhibit [5]. This can be achieved by utilizing the affordances of the instrument. As the most natural affordances of a string is plucking and striking it, our string produced sound just by touching it. This property triggered immediate curiosity among the users. Such a property is an attribute that is referred to as "attractor" by Edmonds [22]. For prolonged engagement, the system needs to give the user the opportunity or desire to explore, experiment or challenge themselves, attributes that Edmonds refer to as "sustainers".

The augmented string offered elements of discoverability through different types of sounds and effects that could be triggered. The users could explore these functions by interacting with the string in various ways. The way our participants approached the string seems to depend on their musical background and age (or more precisely, the lack of certain experiences, rules and norms that you obtain as you get older). The children interacted with the string more intensely, while adults had a more thoughtful approach and at times stepped back from the instrument in order to reflect on their actions and the strings responses. The children's seemingly less reflective behavior can perhaps cause them to be guided by the design of the system, if they are continuously "rewarded" by a certain interaction.

With traditional string instruments, the volume is directly proportional to the amplitude of the strings vibrations, which can be dampened more easily when striking the string with the hand instead of plucking or pulling it. The risk of dampening the strings vibrations was not the case with our string as the volume instead was connected to the force applied by the participant when the piezo detected an attack. This, in combination with the lack of (or a different) conceptual model of how string instruments work, might be the reason to why none of the children pulled the string, and only one child plucked the string before quickly moving on to more intense interactions. This less reflective behavior is worth taking into consideration if a particular interaction is desired by the designer, and certain limitations might need to be set in order for children to not overlook "less-rewarding" interactions.

The childrens lack of certain behavioral rules and norms might also be the reason for interacting differently then the adults, such as boxing, kicking and hitting the string with their head. It might be important to consider the way children interacted with the string when designing for public installations. Seeing how the children were more focused on exploring than on completing a challenge (like playing a melody), can be important to provide discoverable functionalities and sound effects for their way of interacting in order to encourage prolonged engagement. Basic musical characteristics like duration, volume and timbre should perhaps be associated to more common modes of interaction as a way to keep the user's explorative journey moving forward to the next levels of engagement; experimentations and challenges.

It was more obvious how the adults were more systematic in their explorations than the children, especially among those with more musical experiences, who for example expected a different pitch at different heights of the string (associating it with a guitar or a piano), or that the direction they hit the string from should affect the sound. The most common type of experimentation among the adults was trying to achieve the same note by hitting the string at the same place or with the same force, but instead it yielded unexpected results. The children were also seen hitting the string at the same place consecutive times, but perhaps for a more exploratory reason due to its "randomness" (being "rewarded" with a new sound with almost every strike), as none of them explicitly tried to control the sound in that way in order to play a melody (unlike all the adults). Some users noted a difference in volume depending on the force applied, but the correlation was unclear. This was probably because the force also triggered different sounds, thereby also disturbing the sounds perceived dynamics.

The most commonly expressed challenge among the participants was, as previously mentioned, to play a melody or a song. This was probably due to the augmented strings natural associations with traditional string instruments, leading to natural expectations of being able to play a melody. Some users also thought that many notes and sounds could be played simultaneously, probably due to the same associations. Although the string failed to meet these expectations, most of the participants still felt they had a fun experience of exploring and experimenting. Some even blamed themselves for these shortcomings of the string by assuming that they did not have the musical skills needed to play melodies. On the other hand, those who had musical background and experience of playing instruments, became frustrated and irritated by the strings shortcomings.

Although we used sensors with good resolution, the sensing methods were not reliable enough to provide a responsive and expressive experience. While it is difficult to talk about originality in regards to the users ideas of interaction, due the low number of test participants and the study setup, it is notable that none of the participants felt that they could create original music with a clear melodic structure. It was especially the uncontrollable pitch that users felt prevented creativity, as expressed by one of the more musically experienced users, it "was the main obstacle for being creative".

A refinement of the prototype is required in order to make it more controllable. For instance, providing a way to control pitch is vital to support creating melodies. This could be achieved by using other sensing methods or evaluating other types of interactions suitable for controlling pitch. Pitch control could also be omitted from the instrument, which could instead provide an explorative soundscape. However, this might not create an equally engaging experience for musically experienced users. Implementing a predetermined melody loop might also be an option, but causes the instrument to lose some of its open-ended qualities.

One of the most appreciated and engaging elements of the instrument among the participants was its discoverability. This element should definitely be retained by providing exploratory sounds or effects for less common interactions (like kicking and heavy shaking), while keeping fundamental functionalities (like volume and/or pitch) to common ways of interactions, unlike the prototype presented in this paper where changing the type of sound interfered with the control of the notes volume.

Acknowledging that interactive exhibits are especially attractive to children and their families [6], along with our result that demonstrates substantial differences in how adults and children approach a string, particularly stresses the need to consider age when designing interactive exhibits in public settings.

7. CONCLUSION

In this study we have looked at how people interact and experience a large size augmented string instrument, intended for a museum installation.

The explorative elements of the installation proved to be the most engaging among children, therefore it seems important to design discoverable functionalities for their intense and sometimes unconventional ways of interacting with the string. The self-imposed and more traditional challenges created by adults (e.g. playing a melody) need to be treated in a satisfactory but balanced way, in order to meet them.

Previous research has highlighted the importance of layering different levels of engagement, to prolong use, in installations in public settings. Our study adds to this by highlighting that we also need to account for different age and musical backgrounds when designing these kinds of installations. Furthermore, to make sure that users dare to explore and experiment with the installation, it is important that it is perceived as stable, controllable, and enduring.

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