MuseumsForward

Looking into the water: Examining visitor reflections of touch tank experiences

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Abstract

Touch tanks are a ubiquitous part of most aquariums in the United States, an exhibit where visitors engage in multisensory educational interactions. The purpose of this study is to examine people's long-term reflections of their touch tank experiences. An online survey and nested, semi-structured interview were conducted to explore how visitors experienced the exhibit and to examine individual reflections more fully. The survey was completed by 123 adult visitors online, and 21 nested, semi-structured interviews were conducted post-survey. The results show that participants considered their social interactions with educators to be of importance. They spoke of their experience using sensory language and referred to their affective states when describing it. The participants also reflected that the design of the touch tank and its physical context were important, and that a sense of safety for themselves and the animals often actively engaged their empathy for animals. Specific to a subset of participants, they also recalled the physical impacts of the COVID-19 pandemic on their touch tank experience. These are the most salient themes to emerge from these reflections of touch tanks experiences that took place both before and during the pandemic.

Keywords

COVID-19; Touch Tanks; Learning; Reflections; Aquariums; Museums

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Introduction

While there are no formal statistics for how many touch tanks exist in aquariums throughout the United States, these exhibits are seen by many as engaging and ubiquitous. Touch tank experiences are known for rich animal interactions that allow visitors to explore, talk about and connect with simulated shoreline ecosystems or other habitats and their residents in a social context. Most touch tank researchers have looked at these experiences specifically to understand if, and what, people might learn at these exhibits through the lens of sociocultural learning (Rowe & Kisiel, 2012; see also Kopczak et al., 2015; Briseño-Garzón, 2014; Rowe, 2018).

The ground-breaking, *in situ* study on family engagement and the potential for learning at touch tanks by Rowe and Kisiel (2006) found that most of their participants spent between five and twenty minutes engaged at a touch tank, the length seemingly determined by the interactions that happen there. And yet there have been few, if any, studies done to follow-up on these brief experiences, to specifically examine visitors' reflections of their interactions outside of the physical space of the aquarium, or museum, over time.

The liminality of the COVID-19 pandemic time provided a unique opportunity to examine those long-term reflections of visitors to touch tanks and to characterize these reflections into themes. Therefore, this study is framed by a consideration and exploration of the relationships between embodied cognitive experiences, such as touch interactions, and long-term memory and learning in free-choice settings, as well as the impact of time on visitors' reflections.

Touch & Memory: Haptic Experiences & Embodied Cognition

Touch

Touch is one of the first senses to develop in humans and is critical to how we learn about and from the world around us, from information acquisition to environmental manipulation. This is an especially important facet of learning at touch tanks: behaviors at these exhibits are exploratory and intentional and involve active touch. Active sensing, as it is defined by Prescott et al. (2011), is purposive and information seeking and "involves tactile and proprioceptive sensing under the

control of movement." A study on haptic experiences by Ackerman et al. (2010) found that "physically manipulating objects can enhance sensory sensitivity, improving information acquisition" in humans and that even basic tactile sensations can influence higher social cognitive processing. Furthermore, it notes that "sensory and effector capabilities [of the hand] facilitate learning, communication, the development of social bonds, and a host of other fundamental processes" (Ackerman et al., 2010; Gallace & Spence, 2010). And recent research by Hutmacher and Kuhbander (2018) has shown that "detailed, durable, long-term memory representations are stored as a natural product of haptic perception."

Embodied Cognition

Embodied cognition is a theory that believes that "cognition is embodied when it is deeply dependent upon features of the physical body of an agent, that is, when aspects of the agent's body beyond the brain play a significant causal or physically constitutive role in cognitive processing" (Wilson & Foglia, 2017). Work by William Winn (2002) explains that "our physical behavior often externalizes our thinking and extends cognition beyond our brain" and elaborates that "the embodiment of cognition in physical action and the embeddedness of cognition in the environment are closely connected." In fact, according to Novak and Schwan (2020), it is haptic exploration that allows for an enriched mental representation of the interaction (Hutmacher & Kuhbandner, 2018; see also Lacey & Sathian, 2014), and it also offers offline emulation of actions by the cognitive system due to reactivated stored efferent actions (Glenberg et al., 2013; Grush, 2004) that, combined with visual imagery, can result in mental simulations of things that the person is recalling, which "increases the frequencies of gestures during verbal descriptions of object manipulations" (Novak & Schwan, 2020; see also Hostetter & Alibali, 2008; Kamermans et al., 2019;). Most importantly, a synthesis of current literature by Madan and Singhal (2012) proposes a hypothesis that "our physical movements…can affect our ability to remember," and found that "the role of our body in memory processes may be much more prevalent than previously believed."

Contextual Model of Learning & Time

This study relies on the *Contextual Model of Learning* framework, developed by Dierking and Falk (2000), that frames learning as a

process that involves three "overlapping contexts: the personal, the sociocultural, and the physical," to more deeply explore the unique context of a touch tank that is situated in a space that typically does not focus on hands-on experiences. Specifically, this framework accounts for the fact that learning in informal learning spaces is deeply dependent on what they call "enabling contexts"—those contexts that "occur outside the museum walls weeks, months, and often years later" that are "as critical to learning from museums as are the events inside the museum" (Dierking & Falk, 2000).

However, most touch tank studies have been primarily focused on the visitor experience while the visitor is in the physical space of the aquarium at a particular time. This has led to a gap in the literature that considers the learning that may occur over time after a person's visit to a touch tank.

> Because learning is contextualized, if the visit is to have any long-term impact then time is required to allow learning to find relevance and be transferred from the context of the museum to other contexts in the visitor's life situations." (Rennie & Johnston, 2004)

Therefore, it is important to consider visitors' long-term reflections of these experiences as they align with the *Contextual Model of Learning* framework, as it may impact the learning that may, or may not, result from the on-site experience. According to work by Anderson, Storksdieck and Spock (2006) that examined the role of long-term impacts of museum visits, "learning is best conceptualized from the visitors' perspective and…needs to be based on and tied to the visitors' overall museum experiences."

Reflections as Long-Term Museum Learning

Researchers of free-choice learning have looked at various aspects of long-term learning arising from museum experiences and found that "most learning indicators, while declining from the immediate post visit measurement to one conducted weeks or months later, tend to remain higher than prior to the visit" (Anderson, Storksdieck & Spock, 2006). Other researchers have found that "sharing experiences with others through conversations or by expressing emotions of the visits such as enjoyment, curiosity, frustration, and anger helps shape and enforce memories and therefore the subjective impact of a museum visit" (Anderson, Storksdieck & Spock, 2006; see also Stevenson, 1991; Medved & Oatley, 2000). Anderson, Storksdieck and Spock (2006) also

argue that there are few studies that look specifically at the long-term impacts of museum experiences, and of those, most prefer to look at impacts over relatively short periods of time. These researchers' work untangling the multiple dimensions of this problem space provided an opportunity to look at long-term impacts of visits to a touch tank through visitor reflections. For this reason, the purpose of this study is to examine visitors' reflections of their touch tank experiences over time to extract the most salient parts of their experiences at these exhibits.

Methodology

Study Design

This study utilized a inductive, qualitative, and descriptive design using an online survey and nested interviews to examine visitor reflections of a touch tank experience at an aquarium or museum prior or during the COVID-19 pandemic.

Subjects & Recruitment

The study focused specifically on the experiences of adult visitors to aquariums who have interacted with touch tanks in some capacity over the previous two years, either preceding or during the COVID-19 pandemic. Subjects were recruited through a newsletter of one large AZA- accredited aquarium and other smaller, regional aquariums, marine centers and museums with touch tanks and they utilized their member lists and social media to disseminate the link to the survey using non-probability sampling in which participants self-selected to participate. Participating aquariums included the Georgia Aquarium, Santa Cruz Natural History Museum in California, Feiro Marine Life Center in Washington, and Seacoast Science Center in New Hampshire. The Principal Investigator of this study also utilized social media and other social capital to disseminate the link to the survey.

Participants & Group Composition

This study consists of 123 surveys completed and 21 nested, semi-structured interviews. The basic demographics were: 77% of the respondents were female (n=95), and 82% had a bachelor's degree or higher (n=101). 47% of respondents reported that they had 1 or more children (n=58), while 52% reported no children (n=64). 65% of respondents reported that they visited prior to the pandemic (n=80).

For those that visited during the pandemic (n=43), 84% noted that the touch tanks they visited were open for touch experiences during the visit (n=36). Only 16% noted closures. This number may be smaller for many reasons: because fewer aquariums were open during the pandemic or because those that did visit were not recruited or those that visited did not choose to participate.

All respondents were between the ages of 25 to 54, with most being between the ages of 35 and 44. They fell into three categories: solo visitors, groups with children and groups without children. The largest group was visitors in groups with children, comprising 50% of the respondents (n=61), while visitors in groups with no children comprised 32% of the respondents (n=39), and solo visitors accounted for 18% of the total respondents (n=123).

Data Collection

Data was collected over a month from March 1st through March 29th, using an online survey on the SurveyMonkey (https://www.surveymonkey.com) platform, and a nested, semi-structured interview was conducted over Zoom (https://zoom.us/). Because the research was done under restrictions related to the COVID-19 pandemic, and it could not be done *in situ*, the study was designed and conducted online, requiring that the participants recall their experiences at a touch tank over the previous two years, encompassing time prior to the pandemic and the times during the pandemic that allowed aquariums to open their doors again briefly.

Survey

The survey consisted of a combination of 23 closed and open-ended questions. After data cleaning, the sample under study consisted of 123 complete surveys, a completion rate of approximately 54% from 232 total surveys attempted. Typical time to completion averaged 4 minutes. The survey covered two primary lines of inquiry: context and learning. The context portion of the survey conditionally examined the physical and situational aspects of the visitor's touch tank experience, while the learning portion explored the cognitive context and experiential portion of their solo and group interactions during or after the touch tank experience. The survey was broken up using survey logic to target specific visitor contexts: those who visited prior to the pandemic, those who visited during the pandemic with open touch

tanks and those who visited during the pandemic but while touch tanks were closed.

Consent language and screening questions were added at the beginning of the survey to ensure that the participants were adults within a specific demographic, namely adult visitors who were not volunteers or staff of any aquariums. Demographic questions about age, gender, and educational level were also included to better contextualize specific background characteristics of the subjects included in this study.

From the survey, the respondents were asked if they would participate in a follow-up interview for which they self-selected to participate.

Nested, Semi-Structured Interviews

The nested, semi-structured interview sought to delve deeper into specific aspects of the visitor's touch tank experience to explore the cognitive context of their visit and untangle the experiential portion of their solo and/or group interactions related to learning during or after the touch tank experience. It consisted of a series of open-ended questions connected to and expanding on answers given in the survey. The participants opted-in to the interview by responding to a recruiting question at the end of the survey. They then were sent an email with a link to the platform, Calendly (https://calendly.com/), to schedule their interview, after which they were sent a follow-up email with a link they used to connect to the researcher at the appropriate day and time. The interview was completed using Zoom and subjects were recruited through the previous survey channels using non-probability sampling in which they self-selected to participate. The sample consisted of 21 interviews lasting between twenty and forty-five minutes.

Because this research could not be performed *in situ*, requiring the participant to recall experiences that may have happened up to two years prior, a PowerPoint slide show was shared with the participants that allowed the visitor to have a visual focus during the interview. They were shown a montage video of touch tanks to help set context for the questions they would be asked. They were also asked warm-up reflection questions to understand their feelings about touch tank exhibits more generally. The interview was divided into four sections:

Walkthrough and Motivation. These questions asked the participants to describe their motivations for visiting an aquarium and seeking out a touch tank specifically and asked them to walk the interviewer through their experience using sensory language to the best of their ability.

Experiences. This section asked the participant to reflect on how touching or not touching impacted their experience.

Social Learning. The questions in this section referred to their survey answers pertaining to their experience interacting, or not interacting, with others in the touch tank space, and asking them to reflect on other ways they may have been able to access information at the exhibit.

Takeaways. The final section invited the participant to recall their favorite parts of the touch tank and to provide the interviewer with any additional takeaways from their experience. It included questions about post-visit interactions and asked the participant to offer opinions or suggestions about what they would change about their experience to facilitate a better learning environment for themselves.

Data Analysis

To prepare for data analysis, incomplete or corrupt surveys were removed, and cleaning was done on the interview transcripts to ensure accuracy of the data prior to coding, removing extraneous words like *um* or *like* to represent the respondents' answers more clearly, and to correct for Zoom transcription errors.

Analysis of the data, both qualitative and quantitative, was done through the Dedoose (https://www.dedoose.com/) platform. The Dedoose system allowed the researcher to define and store codes that emerged from thematically analyzing qualitative data. This allowed the researcher to assign meaningful codes to portions of transcripts or survey open-ended questions that best illustrated the themes that emerged. The coding was then re-evaluated to refine the codes to best describe the emergent themes from the qualitative data. Quantitative data from the survey was analyzed through Dedoose for code frequencies and percentages.

Results & Discussion

Characterizing Reflections

The seven most salient themes that emerged from the reflections of the participants of this study were ones that could be broadly described as fitting into three contexts: sociocultural, personal, and physical, which suggests alignment with the *Contextual Model of Learning* framework (Dierking & Falk, 2000). The participants reflected on the social presence and quality of educators at the touch tanks. They vividly recalled their personal sensory experience, while also

reflecting on their feelings of safety and empathy, and they discussed their personal affectiveness during these experiences. Finally, they reflected on the physical elements of the touch tank that included both structure and the impacts of the COVID-19 pandemic on their experience.

The Social Visits

Results from the survey suggests that visits to a touch tank are inherently social, with 71% of respondents noting that they actively talked to each other about what they were doing at the touch tank (n=103). This is consistent with findings from Rowe and Kisiel (2012), whose study on family engagement at touch tanks revealed the presence of the 'debrief,' which are questions or discussions that mediate the touching interactions. However, most respondents, when asked, could not recall what those debriefs entailed which could suggest that these within- group interactions were potentially more important for fulfilling the visitors' social needs than the content of the conversations. However, across the board, most visitors' reflections of their experience focused on the interactions with and quality of educators at the touch tank.

Interactions with Educator at Tank

The most important social theme to emerge from the interviews was the importance of the interaction with an educator at the touch tank. Findings from both the survey and interview support a study that found there was a need for more guided discourse and interaction between staff (Kopczak et al., 2015) and visitors while at touch tanks to increase ecological talk and is further supported by the Vygotskian sociocultural learning theory concepts of scaffolding, the zone of proximal development and the more knowledgeable other (Vygotsky, 1978). 60% of 103 survey responses believed that they learned something from an educator at the touch tank, while 52% of the total survey respondents (n=123) talked to a member of their group or educator after their visit. In the interview, respondents could overwhelmingly recall either their or others' interaction with an educator at the touch tank. Most noted that they engaged the educator first:

> They were super enthusiastic and like it took hardly anything to get them to talk. And we did ask questions, but there was very little silence well, both on our sides and on the volunteer's side there was just so many

> stories and so much information, and you know one piece of information led to other questions.

Respondents also noted that being able to ask questions of the educator sparked conversations: “She was telling us about their teeth, how they were different, and they don't really have them, which was something that me and her both know, but it sparked conversation about the animals themselves.” These conversations also provided educational context for the act of touching for some: “I really like when there is someone from the aquarium who can give you information about them so that you can learn more about them, while you're having the experience of getting to touch them.”

Quality of Educator at Tank

A subset of the social factor that emerged as important to the respondents was the quality of the educator stationed at the touch tank. During the interview, many of the interviewees discussed the importance of a high-quality educator to their experience: “I mean the touch tank experiences that I’ve really enjoyed are when the person staffing it is both knowledgeable and assertive in a kind sort of way.” Others noted their demeanor: “I remember that the staff that were monitoring, engaging behind the touch tank were very, very friendly, and welcoming. They spoke about different facts regarding the animals,” and another recalled being excited by the educator: “it was really fun to listen to him and he was so excited to be there which was fun and his enthusiasm was a bit infectious.” Another interviewee recollected that the educator “wasn't just this person giving information, it was like he was available to provide information, but it wasn't someone just standing there talking at us.” There were also interviewees who recalled that their experience with an educator was less than acceptable to them, noting that it directly impacted their experience by making the space inhospitable for asking questions:

> So, he just he was sitting back away from the tank he wasn't at the front of the tank and he's just sort of hunched and he was just sort of yelling at small children, so he didn't seem like he wanted to be asked questions.... the person who was there was purely safeguarding the exhibit, there was no chatting with guests, there was no conveying of information.

Ultimately, most visitors recalled that educators, both their presence and their quality, played a pivotal role at their touch tank exhibit by

supporting their learning, being engaging, and mediating their touch experience.

The Personal Visit

The participants' visits were not entirely social, as many of the themes that emerged from the study suggests that visitors recalled both personal cognitive and affective aspects of their visits. They recalled sensory experiences often, and explored their feelings of safety and empathy, while also speaking of their experiences in terms of how it made them feel.

Sensory Language

When people did choose to have a touch experience, they would use sensory language when recalling or describing the things they were doing and learning, using words like *see, feel, look, touch, noisy, gross,* or *smelly*. In the survey, sensory talk was overwhelmingly prevalent when the respondents talked about their experience: there were at least 58 individual responses to multiple survey questions that contained sensory language. At least 60 people from the total survey respondents (n=123) discussed their sensory experiences with their group or educator after their experience. 52 responses included sensory language when asked if they had learned anything from their experience. And when asked what their favorite experience was, 112 responded with sense words, like *seeing*, *touching*, or *feeling*, often explicitly linking a sense to their encounter: "I absolutely love being able to engage in the touch sense while learning about these animals." Another respondent said: "We would try to count up all the hermit crabs and so that's not touching so much, it's more like looking."

Not only did interviewees use specific sensory-linked words, but they also used descriptive language when talking about things they were sensing: "In it there's a bunch of the really, really pretty marbled rays and patterned kind of freshwater fish that you can walk over and look straight down on and so that was what we were excited to see." Some interviewees explicitly connected sense and memories: "I feel like engaging the senses really drives home the specific memories" or they tied their experience directly to their senses:

> If I look at a tank that has sea stars in it, it's only one sensory experience. But then, when you can touch them, you get a more sensory enriched experience, and

> so I think you can connect with it and it's just so cool to be able to touch the animals.

Feelings of Safety and Empathy

From those who visited during the pandemic, another major theme that emerged from the survey and interviews was the respondents' concern about safety: both for themselves and their interpersonal interactions, but also concern about the safety of the animals. "I was worried the kids would get too close to other children and didn't know if the germs could spread in a touch tank." From the 21 interviews, there were over 28 mentions of COVID-19 related safety concerns or considerations, such as feelings about sanitation safety:

> As far as being worried about it being sanitary or COVID or anything like that. There was zero worry for me as far as the touch tank goes. I think they're actually a great experience: it's actually very clean because of them having readily available sinks, for you [to] wash your hands after you touch the animals anyway, you know.

From the open-ended survey questions, 21% of respondents' answers contained talk about COVID-related safety (n=123), like the use of masks or social distancing. Careful touching and handling of animals were mentioned explicitly 13 times in the interview, with the two-finger touch rule specifically mentioned as an important rule for interacting with the animals: "you could gently touch the top with two fingers, you couldn't do any more than that which I think that's just enough where you can engage your senses but keeping the animal's comfort in the front of your mind."

Empathy or empathetic interactions, like the response above, were mentioned 19 times during the interviews, with respondents suggesting that animal choice to engage during this interaction is important to them: "They had a lot of room to not interact with people, but they were choosing to interact with people. There was definitely enough room that they could have stayed far away from being touched." They also showed concern about the effects of touching on the animals themselves: "I also feel... nervous for the animals because you never know whether people are going to have stuff on their hands that's going to harm them or like be too rough, especially kids." Visitors also seemed to be concerned about animal care, and one visitor remarked,

after seeing what appeared to be cramped conditions for sturgeons: “If I was in that situation, I'd probably feel fairly cramped.”

Affect

In this study, a related theme to emerge from the interviews was that respondents’ experiences were affective in nature, with many respondents sharing their feelings, from empathetic responses for animals like: “I try to be really careful not to touch anything at random, you know there are animals in there so be careful,” to metacognitive reflections:

> I guess you always have hypotheses in your mind about what you know, at least by what something looks like or maybe what you just imagine they would feel like, and you know those are always challenged or confirmed whenever you touch the animal and that’s very satisfying to me.

Emotive responses were also represented heavily in the interviews, with interviewees recalling that their experience made them feel excited, or that it reminded them of something in their life or of memories that resulted from their sensory experience.

> I remember my dad telling me he had been in the Navy, and this was back in the 50s, and they were in the tropics and the artillery men thought it was a good sport to try to aim for a large ray and they hit it, and how incredibly large it was and it saddened my father to watch the fins just kind of curl up as it sank….I got a sense for the creature…like a sense for how sad that would have made my father feel because they were amazing little animals.

These results support findings from Briseño-Garzón, et al. (2007), that participants who had diverse emotional and affective responses to contact with living creatures were experiencing higher order learning, which is based off the work of Wellington (1990) that links educational goals and affective domain to long term, positive cognitive impacts.

The Physical Visit

The importance of the physical aspect of the visitor experience emerged from both the survey and the interviews. Respondents’

recollections of the design and context of the touch tank, and physical changes to the experience because of the COVID-19 pandemic were the most recalled themes that emerged from the data.

From analysis of the interviews, 52% of the interviewees (n=21) recalled general and/or specific structural elements of the touch tank exhibit in the context of their overall aquarium experience, with five specifically tying realistic touch tank design to previously learned ecological concepts or specific physical places. One visitor stated that "it [the touch tank] blends into the entire upstairs ecosystem that they've built, it just feels really, really different from where you just have a glass concrete tank." Others tied the touch tank to ecological spaces, with one interviewee saying that it "sort of looks like what you would see in a tide pool," and another saying that "it was almost like there was a piece of the ocean that was there, and that's why I like seeing the sand on the bottom." The interviewees also found that many of the touch tanks they visited had distinctive placement inside the aquarium that made the exhibit memorable, from being separate from the rest of the viewing-only tanks to what one interviewee described as "somewhat of a centerpiece." These findings suggest that some visitors consider the physical context of both the design and placement of the touch tank as important to their experience.

COVID-19

The COVID-19 pandemic was very much on the minds of those survey respondents who chose to visit during the pandemic. They noted that there were physical limitations for visiting the aquarium: "you have to go online and actually register, you can't just walk up and get in…you probably have to, about a week out, make a reservation and then you get a 30-minute window." And interviewees recalled that there were operational changes, as well:

> You immediately have to do a bunch of interactions: they asked you COVID questions, they don't want you using hand sanitizer obviously before you touch the critters, so they have you wash your hands…health and safety stuff for COVID.

And numbers of visitors were reduced, with some spaces reducing attendance to one household at a time at limited times. They were also very aware of physical changes to the exhibit space, recalling that: "they do go on more breaks and then they actually have sectioned off little, you know, four- or five-foot areas that are separated by plexiglass so

that you can go experience to touch tanks." Some also spoke about logistical changes to how they could move through the space: "there's a single route that you take through the aquarium. And it does walk you around through the touch tank. They've asked that you minimize touching the rock space." In short, visitors understood that the pandemic had changed and impacted their visits, with one person noting that "the COVID era is full of arrows and directions."

Conclusions

Overall, this study shows that participants, even after long periods of time, can still recall and reflect clearly on their touch tank experiences. These findings align with previous studies done on the impact of long-term museum experiences, as summarized in the work of Anderson, Storksdieck and Spock (2006). Particularly, in the studies by Anderson (2003) and Falk and Dierking (1990) that showed that long-term memories over years focus on the social context of an experience, participants in this study strongly remembered their social interactions at the touch tanks, even if they could not recall specific details. They also considered the educators at the tanks to be one of the most memorable parts of their experience, strongly perceiving them as facilitators of learning. Falk and Dierking (2000) note that sociocultural mediation plays a role in personalizing the exhibit experience for the visitor and is an integral part of contextualization that "enhances people's ability to remember the experience." The effect of this personalization was evident in the participants' highly sensory and affect-linked recollections where they spoke of their touch tank experiences using sensory language, and, as in the work by Medved and Oatley (2000), recalled their affective states when describing their experiences at the exhibit. Furthermore, even the design of the touch tank and its physical context were particularly affectively salient to participants, actively engaging their empathy for animals during their reflections. The importance of the physical aspects of an exhibit in a free-choice learning space, as detailed by Falk and Dierking (2000) as a significant part of their *Contextual Model of Learning* framework, was also demonstrated when the participants reflected on the COVID-19 pandemic, and specifically recalled physical processes, benefits, and limitations that impacted their touch tank experience.

The salience of these themes for the participants emphasizes the uniqueness of the multimodal experiences that occur around touch tanks that combine sensory, social, and affective elements. This combination of aspects may be a key to understanding how people

retain such vivid and reflective memories over time. This can potentially be leveraged by aquariums and other spaces with touch tanks to increase engagement at these exhibits through interpretation that considers the three larger themes as connected, rather than separate aspects, during a touch tank experience.

Limitations

Circumstances around the COVID-19 pandemic impacted this study and required a redefinition of some the methods used to undertake this research. Research during this time could not be done *in situ* due to strict regulations and site closures, and therefore had to be adapted using online technologies. Specific pandemic-related pressure on aquariums also led to staff lay-offs, cuts in hours, and a decrease in availability and capacity for individual staff members. Many larger aquariums were either closed or declined to participate due to reasons such as staff capacity or bureaucratic barriers. Overall, COVID-related impacts (limited-access to sites, visitors, and staff) coupled with external COVID-related impacts (emotional fatigue, zoom fatigue, and lack of visitor access to touch tanks) may also have impacted the quality and quantity of responses. Had this study been done during a non-pandemic year, the data may have looked different, but because there were complex and varied stresses on the participants' personal lives during this year, it is impossible to say whether their responses were more emotionally engaged or whether they would have looked like responses that would occur during a non-pandemic year.

The use of social media to further disseminate the survey, while effective for the circumstances, may also have biased the study by engaging participants already highly engaged with museums, aquariums or other formal or informal learning institutions. The demographics of the sample seemed to skew toward more highly educated, highly engaged individuals; and as such, may not reflect the wider range of aquarium visitors. And because demographics were not heavily emphasized in the early stages of this study, as the authors considered including racial and other highly personal demographics to be a source of bias as the study was originally planned, there was a lack of biographical data to support broader conclusions. As the study evolved, the lack of these demographics became a clear limitation: having this information would have made the data more meaningful in understanding the bigger picture of the visitor experience and brought to light important identity-related data that would have made this study more robust. Having a more holistic view of a visitor's experience that

includes biographical data would have been supported by Anderson, Storksdieck and Spock (2006), who believe that having more biographical research would strongly link pre-and-post experiences with a visitor's museum visit.

Implications for Future Research

Because most aquarium touch tank research and evaluative studies focus on visitors while on site, future examinations of the long-term reflections of their experiences may be critical to understanding the long-term impacts of a visit to a touch tank. For aquariums and other spaces with touch tanks, these studies may provide multiple pathways to explore the specific contextual visitor experiences that are unique to a touch tank experience, from animal empathy to the relationship between physical touch interactions and learning.

Long-term reflective studies can also provide the greater museum field with a deeper understanding of the importance of educators at exhibits and may also allow reflection on what visitors find meaningful in exhibits, which may prompt the need for more refined exhibit designs that can be affectively impactful while also being mission oriented. Long-term reflective studies are important opportunities for the broader field to learn more about their visitors and their communities outside of the context of their institution, specifically, and to explore the impacts of the work being done by the field, more generally.

Based on the results of this study, we believe that while there are many implications for future research, especially those detailed by Anderson, Storksdieck and Spock (2006), there are two implications we think are important for future research into long-term reflections of touch tank experiences. Previous work done by Dierking and Falk (1997) on the long-term impact of school field trips showed that "cognition and affect, cognition and the physical context, and cognition and social context" had strong interrelationships. Because of the salient sensory and affective themes that emerged in participants' reflections in this study, we suggest that future studies further examine those contexts to explore how, and if, the sensory and affective experiences at a touch tank, embedded within the sociocultural context, can enhance visitors' long-term reflections. Future work in this area will clarify the unique sensory and social experiences that happens around a touch tank and may support how to better leverage these experiences on site to provide a more meaningful and impactful experience for visitors over time.

Given that personal reflections rely on memories of experiences, we believe that future studies should also explore touch tanks and their relationship to two types of memories: episodic and semantic. The results of this study revealed that there were robust conversations of episodic memories, those memories that deal with affect, emotions/feelings, place, and particular events (Anderson et al, 2006), however researchers have shown that the semantic memories people make, that deal with facts and concepts, takes "subsequent reinforcing experiences or a strong personal connection to the topic or content" (Stevenson, 1991; Storksdieck and Falk, 2006; Falk,

2006). Future research can potentially explore how aquariums can strengthen the link between these two types of memories given that most measurement of impacts at touch tanks happens on site, rather than over long periods time. This will be helpful for evaluative studies that want to explore long-term memory and learning from touch tanks.

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We have no conflict of interest to disclose.

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