

# **Observing the Rotifer – Part One**

## ***Seeing Scientifically 2.0 (Phase 1)*** **Front-End Evaluation**

Joyce Ma

May 2021

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### **SUMMARY**

This front-end study used an online survey as a first step in understanding what informal learners may find interesting about the rotifer, *Brachionus*, a candidate specimen being considered for the first *Seeing Scientifically* microscope exhibit. It collected questions respondents had about this specimen, which could seed lines of inquiry to support, and identified salient features people noted from which the project could develop deeper observation experiences. Overall, the survey respondents found the specimen, particularly its eating behavior, compelling. Study participants also generated questions, many of which could be pursued through more careful, scaffolded observation under a microscope, and noticed behaviors and other characteristics of the rotifer that could form a good base for further exploration.

### **BACKGROUND**

*Seeing Scientifically 2.0* is an NSF-funded, *Innovations in Development* project working to better understand how to engage and scaffold informal learners in scientific observation of live, microscopic specimens. In collaboration with our technical partner, the Fletcher Laboratory at UC Berkeley, and two other Informal Science Environments (ISEs), BioBus in Harlem, New York, and the Noyo Center for Marine Science in Fort Bragg, California, the Exploratorium will create and study a new microscope exhibit platform that uses imaging technologies to spark and support visitors' investigations of the dynamic, living microcosm. The platform will be developed to work across different contexts, content, and audiences in an effort to 'democratize' advanced imaging technologies in microscopy.

In its first phase, *Seeing Scientifically* will develop a prototype that features the same specimen across the project's three ISEs, the Exploratorium, BioBus, and the Noyo Center. After vetting a variety of candidate organisms, including local plankton, sea urchins, dinoflagellates, and termite gut protists, the team decided to pursue the marine rotifer, *Brachionus*, because it met a number of criteria (e.g., it is available from commercial suppliers year round, inexpensive, easy to keep alive with minimal infrastructure, and dynamic and visually compelling). However, the team knew little about visitors' interests in this particular organism.

## PURPOSE

This front-end evaluation was conducted to gauge visitors' interest in *Brachionus*. In addition, the study sought to answer the following questions:

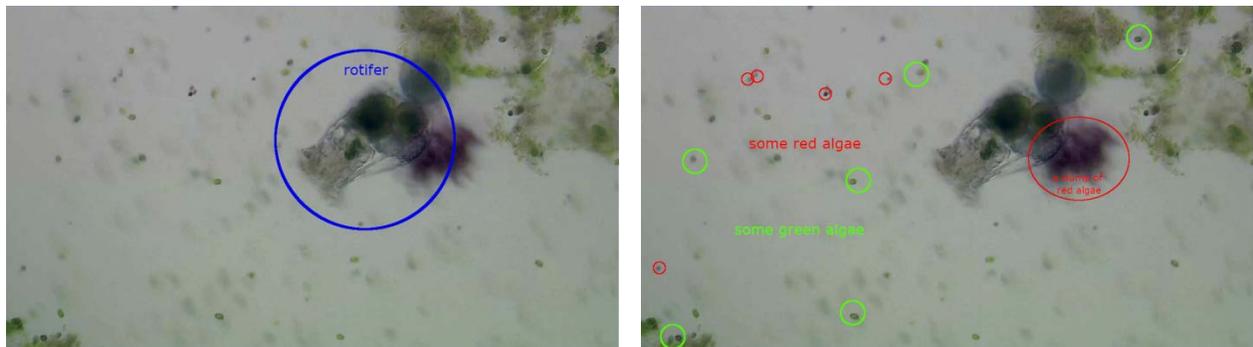
- What, specifically, did people find interesting about the rotifer?
- What questions did they have while watching rotifers under a microscope?
- What did respondents find salient? That is, what did they notice?
- What help did they want understanding what they saw?

Its findings serve to inform:

- What the exhibit should highlight about this specimen.
- The investigations the exhibit may try to encourage and support.
- Features and behaviors already salient to visitors which the exhibit can build on.
- The types of supports that the exhibit should provide.

## METHOD

Ideally, this front-end study would have interviewed people sampled from visitors at the Exploratorium, BioBus, and the Noyo Center. However, because of the COVID-19 pandemic, all three ISE sites were closed to the public, and at the time of the study, it was still unclear when and how any of the sites would reopen. Since many of the technical decisions depended on identifying the featured specimen, the team decided to proceed with a front-end rather than wait.



*Figure 1. Screenshots of the video used in the survey. The video is 1 minute and 40 seconds long taken with a 10X objective under DIC light. It shows one rotifer creating a current with its cilia at its crown that move particles towards its mouth. The jaw grinds what enters. The green mass inside the rotifer is the masticated algae.*

Because the Exploratorium was still engaging with members and other informal science learners through its social media channels and online programming, an online survey seemed to be a promising and practical way of collecting visitor feedback during the COVID shutdowns. As a surrogate for the experience of watching rotifers under a microscope, the project microscopist captured a video of rotifers

feeding on red and green algae (Figure 1) using a magnification and lighting similar to those of the scope under development<sup>1</sup>. The survey, hosted on Qualtrics, consisted of this video, a series of questions about that video, and demographic questions. To keep the survey to a reasonable length, I created two versions, which differed on only two questions. One version asked visitors to *compare* what was happening to the red versus the green algae and to try to explain any differences they noticed, while the other asked visitors to *describe* what they thought was happening and to try to give visual evidence for their conjectures. (See Appendix A for the survey questions.)

To recruit respondents, the Exploratorium's Digital Marketing Manager wrote and posted a series of Instagram stories on May 3<sup>rd</sup>, 12<sup>th</sup>, and 18<sup>th</sup> with a link to the Qualtrics survey. Because of the logistical difficulties in securing guardian consent for minors, only adults were invited to participate. Figure 2 shows the screenshots of those Instagram posts.

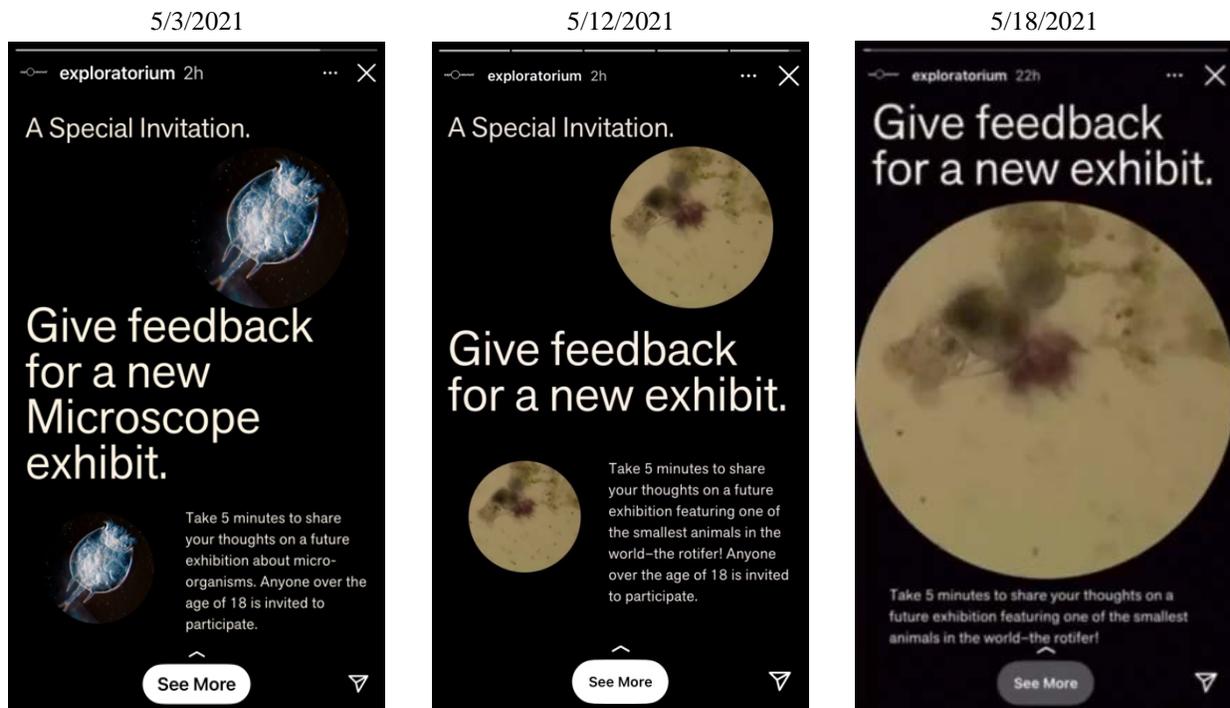


Figure 2. Screenshots of the Instagram Story posts.

## DATA COLLECTED

$N = 25$  surveys were returned, 23 of which were complete.

Table 1 shows the age breakdown of our survey respondents. Compared to data on the Exploratorium's pre-pandemic visitors, our survey was returned by proportionally less 25-44 year-olds.

<sup>1</sup> The *Seeing Scientifically* microscope was still under development and was not used to generate this video.

Table 1. Age of survey respondents.

| Adult Age Group | Count (out of 25) | Fraction of respondents | Fraction of visitors (pre-pandemic data)* |
|-----------------|-------------------|-------------------------|---|
| 18-24           | 8                 | 0.32                    | 0.18                                      |
| 25-34           | 5                 | 0.2                     | 0.31                                      |
| 35-44           | 3                 | 0.12                    | 0.30                                      |
| 45-64           | 7**               | 0.28                    | 0.18                                      |
| 65+             | 2                 | 0.08                    | 0.03                                      |

\* Data from Exploratorium exit interviews collected from July 1, 2018 to June 30, 2019.

\*\* Two of these respondents did not fill out the entire survey.

To ascertain if people taking the online survey were in some ways representative of Exploratorium visitors, the survey asked if they had visited the museum before and if they intend to visit the museum once it reopens. The results are shown in Table 2. All but one person out of the 23 respondents who answered these questions, either had visited in the past or strongly intend to visit in the future. This gave some assurance that most of the respondents were or will be a museum visitor.

Table 2. Respondents who have visited or intend to visit the Exploratorium.

| Has visited the Exploratorium? | Count (out of 25) | Fraction of respondents (23) | Will visit the Exploratorium?     | Count (out of 25) | Fraction of respondents (23) |
|--------------------------------|-------------------|------------------------------|-----------------------------------|-------------------|------------------------------|
| Yes                            | 21                | 0.91                         | Definitely                        | 14                | 0.61                         |
| Not sure                       | 1                 | 0.04                         | Highly likely                     | 4                 | 0.17                         |
| No                             | 1                 | 0.04                         | Not likely                        | 4                 | 0.17                         |
| No response                    | 2                 | -                            | No way                            | 0                 | 0                            |
|                                |                   |                              | Unfamiliar with the Exploratorium | 1                 | 0.04                         |
|                                |                   |                              | No response                       | 2                 | -                            |

Alternatively, to make sure that the survey was not only reaching people with strong ties to the museum, the survey asked if respondents were Exploratorium members and found that 2 out of the 23 who answered the question, had a museum membership (Table 3).

Table 3. Survey respondents' Exploratorium membership.

| Exploratorium Member? | Count (out of 25) | Fraction of respondents (23) |
|-----------------------|-------------------|------------------------------|
| Member                | 21                | 0.91                         |
| Non-member            | 2                 | 0.09                         |
| No response           | 2                 | -                            |

Finally, to gauge prior experience, the survey asked respondents when they last used a microscope and if they had relevant professional, avocational, or academic background that would have helped them understand the video they saw. The results are shown in Table 4 and Table 5, respectively. A majority

(~60%) claimed to have some sort of expertise beyond what a ‘typical’ museum visitor may have looking at the microscopic world.

Table 4. The last time survey respondents used a microscope.

| When respondent last used a microscope | Count (out of 25) | Fraction of respondents (23) |
|--|-------------------|------------------------------|
| Within the last year                   | 7                 | 0.30                         |
| 1 to 5 years ago                       | 13                | 0.57                         |
| Over 5 years ago                       | 2                 | 0.09                         |
| Cannot remember                        | 1                 | 0.04                         |
| No response                            | 2                 | -                            |

Table 5. Survey respondents’ prior relevant experiences.

| Type of relevant experience | Count (out of 25) | Fraction of respondents (23) |
|-----------------------------|-------------------|------------------------------|
| Job                         | 9                 | 0.39                         |
| Hobbies and Interests       | 8                 | 0.35                         |
| Education                   | 9                 | 0.39                         |
| Any                         | 14                | 0.61                         |
| No response                 | 2                 | -                            |

## RESULTS

### What was of interest

To gauge people’s interest in the rotifer as a candidate specimen to feature, the survey asked respondents to rate how interesting they found the video and to explain their rating. On average, most survey takers found the video *Somewhat Interesting*, a rating of 4 on a 5-point Likert scale from *Interesting* (5) to *Not Interesting* (1). The tally is shown in Table 6. This finding provides some initial indication that the rotifer could be a compelling specimen to feature for the first phase of the *Seeing Scientifically* project.

Table 6. Survey respondents’ interest rating.

| Interest rating          | Count (out of 25) | Fraction of respondents (25) |
|--------------------------|-------------------|------------------------------|
| Interesting              | 7                 | 0.28                         |
| Somewhat Interesting     | 12                | 0.48                         |
| Neutral                  | 3                 | 0.12                         |
| Somewhat Not Interesting | 3                 | 0.12                         |
| Not Interesting          | 0                 | 0                            |

When asked what they found interesting, many (17 out of 25) respondents wrote about the phenomenon, specifically the rotifer and the algae's behavior. *Action* seems to hold people's attention, and the results suggest the importance of having a dynamic specimen for visitor exploration. A much smaller number of people also mentioned other factors, including the image quality, the details they saw, and the fact that they enjoyed looking at microscopic life. The different reasons people gave for finding the video interesting are listed in Table 7 along with example quotes.

Table 7. Positive reactions to the video with example quotes.

| Positive reactions   | Examples  |
|--|---|
| Respondents were interested in what the rotifer and algae were doing (17 out of 25 responses). | R16: It showed a rotifer eating and how it uses vortexes to bring food to its mouth.<br>R17: The video has clear movement<br>R20: you can see it interacting with its environment<br>R29: Seeing rotifer ingest the green algae that flowed around it.<br>R33: The rotifer was pretty much VACUUMING up that algae!!!! Neat!!!!<br>R34: It was neat to watch the rotifer feeding, creating currents<br>R37: The movement of the organism.<br>R38: the inner rotifer parts moving to create suction - the outer mouth parts... spinning like a buzz saw<br>R40: the spinning "mechanism" to consume food<br>R41: when it was absorbing the algae |
| They appreciated seeing the fine details of the organisms (3 out of 25 responses).             | R24: details<br>R29: I also liked seeing the color difference between the green and red algae   |
| People liked trying to figure out what was happening in the video (3 out of 25 responses).     | R26: Trying to figure out what the rotifer was doing.<br>R31: Trying to figure out  |
| Respondents appreciated the image quality (2 out of 25 responses).                             | R17: clear ... resolution   |
| People liked looking something microscopic (2 out of 25 responses).                            | R25: Seeing something very small  |

Alternatively, survey respondents found certain aspects of the video not interesting. More specifically, people were disappointed in the lack of information, the image quality and the repetitive nature of the video. One person who self-identified as being colorblind could not distinguish between the red and green algae. Table 8 describes each potential areas of concern.

Table 8. Negative reactions to the video with example quotes.

| Negative reactions   | Quotes  |
|--|---|
| Respondents wanted more information to understand what they were seeing (4 out of 25 responses). | R22: No information about what was going on.<br>R23: Then some other screens explaining what is happening would have been appreciated... It's unclear what is happening (or rather, why it's happening).<br>R32: explanation would've been nice.<br>R39: not knowing what to look for |
| They complained about the image quality (3 out of 25 responses).                                 | R22: Crop in tighter<br>R32: the colors weren't that legible and went by quickly.<br>R39: The aesthetic of it   |
| People thought the video was repetitive (3 out of 25 responses).                                 | R23: Repetitive. I watched about half. I thought it would have something new<br>R27: rather repetitive - after about 10 seconds there wasn't much more to get from watching<br>R41: cool at first   |
| The distinction between red and green was lost on the colorblind (1 out of 25 responses).        | R38: I'm colorblind and couldn't tell the difference between the red and green algae.   |

### What questions were asked

The survey asked respondents to list all the questions that came to mind when watching the video to help identify potentially engaging investigations to support with the exhibit prototype. I coded these questions into three categories: (1) *On Slide*, questions about the specimen observable under a microscope, (2) *Outside Context*, those about the rotifer in relation to the larger context, outside of a slide, and *Other*, questions concerning something other than the specimen, including those about how the video was acquired. Of the three, the *On Slide* questions most directly relate to lines of inquiry a visitor might pursue at the *Seeing Scientifically* exhibit, but the other two categories are also important since they indicate what additional information visitors may need to contextualize and make sense of what they see on the microscope slide. Table 9 gives example questions for each coding category.

All 25 survey takers listed at least one question, with 22 respondents asking at least one *On Slide* question. In total, they generated 121 questions, 99 (92%) *On Slide*, 18 (15%) *Outside Context*, and 4 (3%) *Other* questions. These results suggest that the rotifer can spark people's curiosity and, more importantly, that the questions they ask can be pursued through deeper observation with a microscope.

Table 9. Respondents' questions with examples.

| Question Category   | Examples   |
|---|--|
| <p><i>On Slide</i> – specimen questions about what can be seen on a slide under a microscope</p> <p>(22 out of 25 responses; 82% of all questions generated).</p>             | <p>R16: Could it have a preference in algae?<br/> R17: What process is this?<br/> R20: What is this thing that I'm looking at?<br/> R21: Why was the algae moving?<br/> R22: What is the pocket in the larger structure sucking in and out the small green cells?<br/> R23: Is it eating the algae?<br/> R23: How big are the blobs?<br/> R24: was that its heart beating?<br/> R25: Is that its mouth?<br/> R26: Was it eating?<br/> R27: Did the algae get moved around differently?<br/> R28: do they have a digestive system<br/> R29: What's causing the green algae to flow like that?<br/> R30: What's happening?<br/> R31: Why are the algae swirling in eddys?<br/> R32: What exactly was that<br/> R33: Is it sucking up the algae on its own volition<br/> R34: How is the rotifer creating suction<br/> R35: What caused the swirl currents<br/> R36: Can you See the digestion of the Red/Green algae?<br/> R38: is the rotifer permanently anchored to that spot like a mussel or can it undock and move around?<br/> R39: Is it eating that?<br/> R40: Do these beings experience sentience?<br/> R41: was it injecting or expelling algae?</p> |
| <p><i>Outside Context</i> – specimen questions about its relationship to the larger world, off the slide</p> <p>(10 out of 25 responses; 15% of all questions generated).</p> | <p>R17: Is this unique to these types of organisms?<br/> R21: How does it fit into the rest of the ecosystem?<br/> R23: Where does this occur naturally?<br/> R24: where was this collected?<br/> R28: where do they live<br/> R29: Is there anything that would eat the rotifer?<br/> R33: Can I find one on my own?<br/> R37: What role do they play in the ecosystem?<br/> R39: Is this its somewhat natural environment?<br/> R40: What other life has features like that?</p>   |
| <p><i>Other</i> – non-specimen questions usually about how the video was acquired</p> <p>(3 out of 25 responses; 3% of all questions generated).</p>                          | <p>R26: Will there be more on-screen info?<br/> R32: Was that an electron microscope or?<br/> R33: what kind of camera/microscope setup there is (I want to see a picture of the equipment used).</p>  |

I then took a closer look at the *On Slide* questions and coded each as *descriptive*, *comparative*, or *explanatory*<sup>2</sup> on the assumption that different types or questions would require different set up and scaffolding to answer. For example, comparative questions could only arise if there was something to compare and be answered if the exhibit made it easy to simultaneously observe what is different or similar. Because the codes are hierarchical, with *descriptive* and *explanatory* being at the lowest and highest level, respectively, a question is given the highest level code applicable. Table 10 summarizes the coding scheme used.

The analysis found that out of the total 99 *On Slide* questions, 57 were *descriptive*, 13 were *comparative* and 29 were *explanatory*. Nineteen out of the 25 respondents asked at least one descriptive, 9 asked at least one comparative, and 13 asked at least one explanatory question. The small number of comparative questions was somewhat surprising because we had intentionally set up a comparison between the red and the green algae. This finding hints at the challenges ahead in engaging visitors in comparison.

Table 10. Coding scheme for the type of *On Slide* questions with examples.

| On Slide Question Type  | Examples   |
|---|--|
| <p><i>Descriptive</i> – questions about attributes, behaviors or functions. These are typically <i>What?</i> questions.</p> <p>(19 out of 25 responses; 57% of all <i>On Slide</i> questions generated)</p>                           | <p>R20: Does it do this constantly or only certain times?<br/> R21: What is a rotifer?<br/> R23: What is happening?<br/> R26: What were its body parts?<br/> R29: Does it poop as well as eat?<br/> R33: How big is the rotifer?<br/> R38: what is their function?</p>   |
| <p><i>Comparative</i> – questions asking about what’s similar or different.</p> <p>(9 out of 25 responses; 13% of all <i>On Slide</i> questions generated)</p>  | <p>R16: Could it have a preference in algae?<br/> R25: Maybe more of the green algae is getting eaten?<br/> R26: Does red or green algae make a difference to it?<br/> R27: Did the algae get moved around differently?<br/> R33: Are the red ones smaller?<br/> R35: What's the difference between the algae?</p>   |
| <p><i>Explanatory</i> – questions asking about mechanism, correlations, or causality. These are typically <i>How?</i> and <i>Why?</i> questions.</p> <p>(13 out of 25 responses; 29% of all <i>On Slide</i> questions generated).</p> | <p>R23: Why is it happening?<br/> R25: wondered why the algae looked like that.<br/> R27: Is the rotational swirl due to a small vessel size?<br/> R29: Why does the rotifer catch some algae but not others?<br/> R33: Is it sucking up the algae on its own volition...if so, HOW?<br/> R35: Why are there currents like that?<br/> R40: How does the spinning mouth mechanism work?</p> |

<sup>2</sup> This coding scheme is based on the classification of research questions defined by Dillon (1984) and refined by Alvesson and Sandberg (2013).

### What was salient

To gauge what aspects of the specimen may be salient to people, the survey asked respondents to either (1) *describe* what was happening and to indicate what they saw that made them think so or (2) *compare* what was happening to the red versus the green algae and to explain what may cause any differences they saw. The survey logic randomly assigned people to one of the two versions. This design was motivated, in part, to keep the survey to a manageable length (~ 5 minutes), but it also provided a way to explore using questions to prompt comparison. Because of the low number of respondents, however, I was unable to make any meaningful statistical comparison between the two versions. The following, nonetheless, reports results according to version for completeness.

To identify what respondents observed about the specimen, I coded respondents' entire survey, not just their answers to the *describe* or *compare* questions. This is because their observations about the rotifer and algae appeared throughout their responses. At first, I looked only for mentions of the living organisms but then realized that people also wrote about the current created by the rotifer to catch the algae, its prey. The final coding scheme for the rotifer, algae, and current is described in Table 11 along with example quotes, and the bar chart in Figure 3 shows the tally of respondents for each code and subcode.

Not surprisingly, most (24/25) survey takers mentioned something about the rotifer, with many (19/25) noting that it was eating. Fewer respondents, however, decomposed the process, which may point to an opportunity to help visitors investigate the different aspects of predation and digestion. Fifteen out of the 25 respondents made some mention of the algae; 10 of these 15 were assigned to the *compare* version of the survey. One respondent explained, "I didn't really think about or care about the algae until I was asked to notice something about them." Although a *comparison* question may not have specifically instigated people to compare, a prompt may have, nonetheless, helped people focus on the otherwise overlooked algae.

Table 11. Examples of salient characteristics of the specimen and current mentioned by survey respondents.

| Rotifer                   |                                      | Examples  |
|---------------------------|--------------------------------------|---|
| <i>Behaviors</i>          | Eating                               | R16_Comp: a rotifer eating<br>R20_Comp: it's only eating the green<br>R31_Descr: then eats the algae<br>R32_Descr: seems to be eating some of the green<br>R34_Comp: rotifer feeding<br>R35_Descr: the rotifer is eating the algae<br>R37_Comp: organism is eating<br>R40_Descr: A rotifer is consuming green algae for food.                           |
|                           | Catching something to eat            | R25_Comp: t was sucking in the algae<br>R27_Descr: It looks like the rotifer is hoovering up algae<br>R27_Descr: catching more red than green.<br>R27_Descr: an internal suction<br>R33_Comp: The rotifer was pretty much VACUUMING up that algae<br>R34_Comp: rotifer creating suction<br>R35_Descr: currents are sweeping inwards towards the rotifer |
|                           | Repelling or spitting out a particle | R17_Comp: red algae is repelled away from the rotifer<br>R26_Descr: It appears to be avoiding the green algae.  |
|                           | Other behaviors                      | R23_Comp: Filtering the water<br>R24_Descr: filter<br>R26_Descr: sorting the algae<br>R33_Comp: What is the rotifer attached to<br>R40_Descr: squishing it inside its body<br>R40_Descr: the way the different species interacted   |
| <i>Physical Qualities</i> | Cilia                                | R22_Descr: arms of the rotifer<br>R38_Comp: what were those outer parts that looked like they were spinning?  |
|                           | Mouth                                | R16_Comp: its mouth<br>R22_Descr: pocket in the larger structure sucking in and out the small green cells   |
|                           | Others                               | R22_Descr: a structure that appears to process them<br>R24_Descr: heart beating<br>R31_Descr: rotifer's body<br>R33_Comp: a brain, or something equivalent to one   |

Table 11 Continued

| Algae                     |                       | Examples  |
|---------------------------|-----------------------|---|
| <i>Physical Qualities</i> | Red vs. Green         | R16_Comp: only eating green<br>R25_Comp: More of the green algae<br>R27_Descr: catching more red than green<br>R31_Descr: green or red algae<br>R33_Comp: red ones smaller  |
|                           | Distribution on slide | R16_Comp: There's more green algae in the water column<br>R31_Descr: a clump of red algae<br>R34_Comp: clump of green (algae) in (?) the rotifer  |
|                           | Others                | R25_Comp: the size difference between the algae<br>R33_Comp: a texture thing  |
| <i>Behaviors</i>          | Behavior              | R16_VComp: red algae too clumped up to move<br>R21_VDescr: the algae moving   |
| Currents                  |                       | Examples  |
|                           |                       | R16_VComp: uses vortexes<br>R24_VDescr: currents towards the rotifer<br>R27_VDescr: the mechanism stirring up the fluid<br>R29_VComp: flowed around it<br>R31_VDescr: the rotifer generated a current<br>R31_VDescr: swirling in eddys<br>R34_VComp: creating currents<br>R35_VDescr: swirl currents<br>R39_VDescr: cycling of the dots towards it. |

### What help respondents wanted

When survey takers were asked what would have helped them make sense of what they saw, most (16) of the 23 respondents who answered this question, asked for additional interpretation. Some people wanted a narration and/or an explanation of what happened in the video:

R21: I would just have liked more information about what was actually happening

R26: More on screen info that explains what is happening with the motion and what the rotifer is doing

R35: Any words or explanation of what was happening. I liked seeing the words explaining what was what, but I don't know what was doing what

R38: More freeze frames explaining what's happening!

R40: A description of what was happening

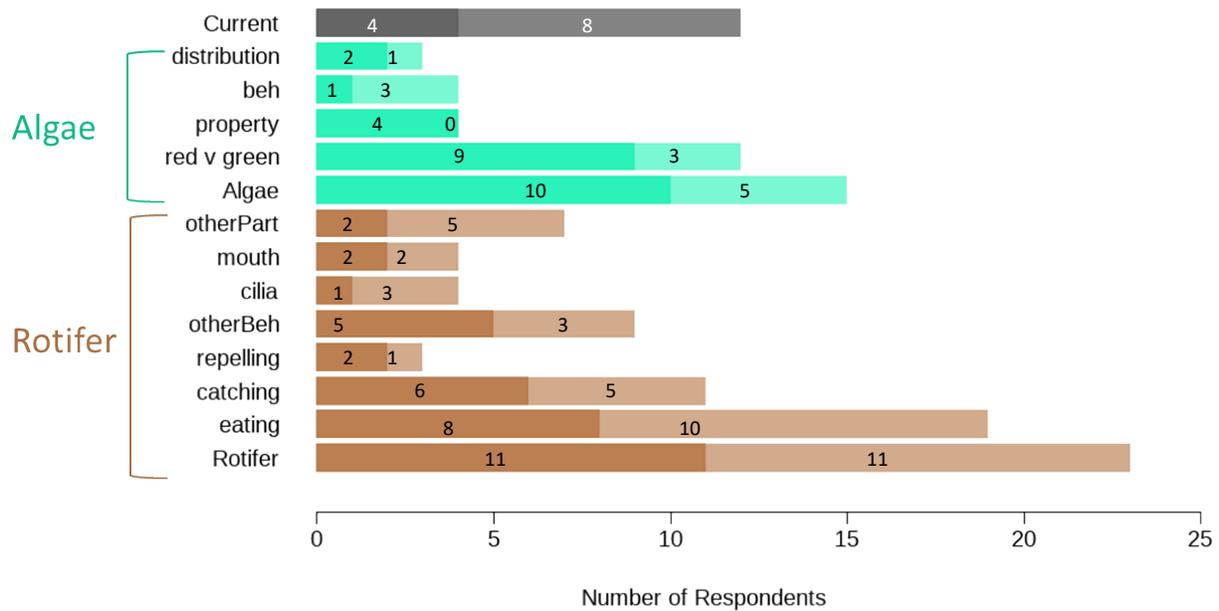


Figure 3. Bar chart of the number of respondents who mentioned an aspect of the rotifer, algae or current. The left, more saturated colors denote the respondents who were randomly assigned to the 'compare' version versus the 'describe' version.

Others were hoping for more context:

R24: more context about the rotifer, where it was collected, what else is in food chain

R33: Context - where is this video taking place, what kind of camera/microscope setup there is (I want to see a picture of the equipment used). What is the rotifer attached to? What else is going on the frame?

R34: Some additional resources about pigments and what/how rotifers feed

These results point to the need to find that delicate balance of providing enough information to help visitors ask meaningful questions while encouraging them to explore and pursue those questions themselves at the *Seeing Scientifically* exhibit.

A few respondents also asked for a clearer visual distinction between the red versus green algae and for better image quality overall. Although the video was captured as a HD 1920x1080, 30fps video, we had no control over the devices survey respondents used. Nonetheless, increasing contrast and providing good enough resolution to see the parts people found compelling are important design considerations to keep in mind.

## NEXT STEPS

This front-end evaluation gave the project team some confidence in pursuing the rotifer as the chosen specimen for *Seeing Scientifically's* first prototype and identified questions and salient features to ground

visitor investigations at our microscope exhibit. However, there are several limitations of this study that cautions against making definitive conclusions. For one, because of the COVID-19 shutdowns, the study was conducted with online participants recruited through the Exploratorium's Instagram followers. Although almost all of the respondents had visited or intend to visit the Exploratorium, it is not clear if they are 'representative' of the Exploratorium audience. In fact, the survey seems to have attracted respondents with a high level of prior experience, with over three quarters reporting having used a microscope within the last 5 years and about 60% claiming to have expertise that helped them understand the video. This coupled with the fact that only 25 people responded to the survey makes me question the representativeness of the sample. Additionally, because of the difficulty in securing guardian consent for minors online, the survey could not capture feedback from anyone under 18. And, everyone who participated in the survey likely watched the video alone, without the distractions that can oftentimes be found on a dynamic floor, and in an online context that can be very different from a museum's.

Finally, the survey largely reached Exploratorium visitors; yet, *Seeing Scientifically* is a partnership among three ISEs, each with an audience that may have potentially different interests, experiences and expectations. In the coming months, evaluation will try to reach the BioBus and Noyo Center visitors for front-end feedback. As each ISE starts to reopen, the project will have additional opportunities through onsite evaluation studies to complement and supplement the front-end results found here.

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## REFERENCE

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## APPENDIX A: Survey Questions

**[Screening question --- survey terminates for anyone under 18]**

But first, what is your age?

- Under 13 years old (1)
- 13-17 years old (2)
- 18-24 years old (3)
- 25-34 years old (4)
- 35-44 years old (5)
- 45-64 years old (6)
- 65 years or older (7)
- Prefer not to say (8)

**Please watch the following video. Feel free to watch for as long or as short a time as you like. The complete video is under 2 minutes long.**

Q1 How interesting did you find the video?

- Interesting (1)
- Somewhat Interesting (2)
- Neutral (3)
- Somewhat Not Interesting (4)
- Not Interesting (5)

Q2 What made the video \_\_\_\_\_?

Q3 Take a minute, and list all the questions that came up for you when you watched the video.

**Here is the same video again. Rewatch as much of it as you want and please answer the additional questions below.**

### Describe Version

Q4\_Descr What do you think is happening in the video?

Q5\_Descr What do you see that makes you think that is happening?

### Compare Version

Q4\_Compare Compare what happens to the red algae vs green algae. What are some of the differences you see?

Q5\_Compare What do you think might cause the differences you notice?

Q6 Please tell us about what, if anything, you wished you had to help you make sense of the video.

**Tell us a little bit about yourself...**

Q7 Do you live in or near the San Francisco Bay Area?

- Yes (1)
- No (2)

Q8 Have you ever visited the Exploratorium in San Francisco?

- Yes (1)
- No (2)
- Not sure / Cannot remember (3)

Q9 Are you a member of the Exploratorium?

- Yes (1)
- No (2)

Q10 Will you visit the Exploratorium in the future when we can safely reopen? (The Exploratorium is currently closed due to the COVID-19 pandemic.)

- Definitely (1)
- Highly likely (2)
- Not likely (3)
- No way (4)
- I don't know what the Exploratorium is (5)

Q11 When was the last time you used a microscope?

- Within the last year (1)
- 1 to 5 years ago (2)
- Over 5 years ago (4)
- Never (5)
- I cannot remember (3)

Q12 Do you have any experiences that you feel helped you make sense of the video you saw? Please check all that applies.

- I have taken relevant coursework. (1)
- I have job experience(s) in this area. (2)
- I have a personal interest in and/or hobbies related to what the video showed. (3)
- Other. Please describe: (4) \_\_\_\_\_