Sketch-and-test: visual crowd research using p5.js

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GitHub repository: https://github.com/maartenwijntjes/p5-sketchn-test
Abstract

Designing visual crowd experiments requires both control and versatility. While behavioural and computer sciences have produced a fair number of tools facilitating this process, a gap remains when it comes to the combination of accessibility and versatility. The Processing language is widely used by artist and designers of varying levels of expertise and thus fulfils these conditions.

Here, we investigated whether the Processing inspired JavaScript library p5.js can be used for visual crowd research. We specifically explored how to use p5.js in combination with MTurk and report a simple way of using p5.js ’sketches to perform online tests.

We report four complementary experimental paradigms to illustrated the accessibility and versatility pf p5.js: Change blindness, BubbleView, Gauge figure (attitude probe) and Composition. Results reveal that previous literature findings can be reproduced and novel insights can easily be achieved.

The creative freedom of p5.js together with low threshold crowd access seems a powerful combination for all areas that involve vision: perception, design, art history, communication and beyond.

Introduction

Collecting behavioural data through online crowd experiments has become a standard research tool for many different scientific disciplines. There are various possible reasons to choose online over lab experiments, such as speed and efficiency but also more specific reasons such as access to certain subject pools (Paolacci et al. 2010). Performance seems generally not to be degraded (Buhrmester et al. 2011) although participants sometimes lack attention Goodman et al. (2013). Most paradigms from experimental psychology give similar results as lab experiments Crump et al. (2013); Haghiri et al. (2019).

Crowd experiments range from simple questionnaires to complex visual presentations. Within the wide spectrum of behavioural sciences that use crowd experiments, researchers on visual perception are particularly concerned about controlling the presentation. Relating physical characteristics of the stimulus to subjective experience is an essential element of psychophysics. To this end, software used by vision scientists is often very customizable and allows for high levels of control. Two packages regularly used are Psychotoolbox (Kleiner et al. n.d.) (PTB, formerly called Psychophysics Toolbox Brainard (1997)) for Matlab and PsychoPy (Peirce et al. 2019) for Python. PTB’s own description reflects that vision scientists require both accuracy and versatility to generate stimuli and collect behavioural data:

The PTB core routines provide access to the display frame buffer and color lookup table, reliably synchronize with the vertical screen retrace, support sub-millisecond timing, expose raw OpenGL commands, support video playback and capture as well as low-latency audio, and facilitate the collection of observer responses.

While PTB is only available off-line, PsychoPy can be run online. To this end, a platform is needed that hosts the JavaScript files generated in PsychoPy and, more importantly, saves the collected data. PsychoPy users can use the platform Pavlovia.org where it is possibly to upload HTML/JavaScript code. Conducting psychophysical studies using JavaScript does not seem to affect control over reaction times (de Leeuw and Motz 2016), a typical dependent variable for vision research. The third step, after coding and hosting an experiment, is recruiting participants, which can be done through crowdsourcing marketplaces, such as MTurk but also many other alternatives.
These three steps (interface design, data collection and recruitment) are inherent components of any (online) experiment. Instead of using a dedicated psychology toolbox, it is possible to directly code an HTML/JavaScript experiment and host it on a web server. Yet, all steps seem relatively high-threshold and to this end, a number of initiatives have been taken to facilitate the online behaviour researcher. For example, psiTurk (Gureckis et al. 2016) is an open source platform that allows researchers to code and use full experiments. One of the motivations behind psiTurk is reproducability: by publishing an online experiment it can easily be reproduced by peer scientists. A difference between psiTurk and PsychoPy is that psiTurk integrates all three steps of coding, hosting and recruitment. Another initiative is TurkPrime (Litman et al. 2017) which focuses more on participant management and MTurk interface for the researcher. As MTurk was originally designed for computer science applications, the interface and management for participants is not well supported.

Considering that a ‘standard’ HIT (Human Intelligence Task) on MTurk through the online requester portal only entails writing some HTML code, it is not immediately evident why the relatively complex solutions mentioned above are needed. It is quite possible to run an experiment directly from the requester portal. However, a lack of HTML/JavaScript expertise can impede the flexibility of stimulus generation and behavioural data collection that is common to PsychoPy and related packages.

Artists and designers face similar challenges: they aim to create rich visual experiences with complex user interactions. A well-known language used by visual artists is Processing. It aims to be accessible to non-programmers and contains a wide variety of graphical possibilities and user input. A JavaScript library having much of the functionality of Processing, p5.js, recently (February 2020) launched its first official version. Over the past few years, p5.js (McCarthy et al. 2015) has attracted a large community of creative coders ranging from beginners to professional artists.

In this paper we report how the p5.js library can be used to program visual experiments for crowd research. Developing stimuli and experiments is particularly accessible through the online editor (https://editor.p5js.org), and with small additions this code can be copy-pasted into the MTurk requester portal. We will exemplify the creative freedom and ease of creating a HIT by reporting four short studies. We used four different experimental paradigms, three of which are rather well known in vision science while the fourth is an example of visual crowd research at large: collecting crowd input for visual tasks is not reserved to the behavioural sciences.

**Methods**

**p5.js & MTurk basics**

The name p5 originates from Proce55ing, an alternative spelling of Processing which is a widely used programming language (Reas and Fry 2007) “in the context of visual arts”*. P5.js is a JavaScript library that shares much of the functionality of Processing (McCarthy et al. 2015). Both Processing and p5.js aim to make code accessible to a wide audience and are thus relatively easy to use by beginners. A program made by a user is called a ‘sketch’, emphasizing the iterative design process with immediate visual feedback. For a general introduction about p5.js we recommend visiting their webpage†. Here, we will discuss a few specific functionalities needed for visual crowd research.

*https://processing.org
†https://p5.js.org
A p5.js sketch is a JavaScript file that uses the commands and structure of the Processing language. In the JavaScript file, images and data are loaded, screen presentation defined and data is collected from mouse movement and keyboard. p5.js even makes it possible to use smartphone events (like orientation and acceleration) as input. When using the MTurk requester portal, the experimenter can choose a template to start coding their own experiment. The HTML, CSS and JavaScript code for a project can be written or copied into the editor. MTurk created a library of custom HTML tags (Crowd HTML Elements) that can be used to save data. The fact that saving data makes use of HTML while p5.js makes use of JavaScript is the first small challenge to be overcome. We found that collecting data in a p5.js Table object is most convenient. When the experiment finishes, the Table is then converted to a CSV file and we use a simple function to transfer this data to the HTML tag.

Besides saving data, experimental design data needs to be loaded. Often a data file is needed that contains sampling points, image names, etc. Again, using a CSV file and importing it as a Table is most convenient. The order of the trials can be randomised to counter balance for order effects. When linking images and scripts from other websites, problems with ‘Cross-Origin Requests Sharing’ can occur. It is not always clear how to change these ‘CORS’ settings on the server or webpage. We found that hosting on Amazon S3 worked well and the relevant settings could easily be adjusted.

We distinguish two phases in our experiment preparation: 1) coding the p5.js sketch (e.g. in the online editor), and 2) putting this code on the MTurk editor. Importantly, we aimed to create experiments that can also (almost) completely run in the p5.js editor (or on any webpage). The biggest difference with MTurk is data collection as it is not possible to save user input in the p5.js online editor, or any ‘normal’ website. As we envision that using p5.js for visual crowd research will also be used in education (the authors use it extensively in a course about visual communication and perception), we propose a simple solution: saving data locally and let participants voluntarily share their data via any form of electronic communication. The scenario will often be that students use their peers as participants. For this, the sketch needs to be ‘aware’ of where it resides: on MTurk or on the editor, for which we wrote a function.

These were general issues of how to use p5.js for visual crowd experiments. We will further discuss specific functions of p5.js during the description of the example experiments below.

**Change blindness**

While the effect is striking and theoretical implications notable (O’Regan 1992), a change blindness experiment is very easy to create. In the original study, two pictures are shown subsequently for 240 ms with a gray frame presented intermittently for 80 ms (Rensink et al. 1996). Humans are surprisingly bad in detecting rather large changes in a visual scene under these conditions. This contrasts considerably with our subjective experience of a richly detailed world (Cohen et al. 2016). The finding implies that we only retain little visual information in our memory, as the world is already ‘out there’ to consult if needed (O’Regan 1992). Besides of fundamental interest, the change blindness paradigm also applies to interface design (Varakin et al. 2004) and to optimize graphics algorithms (Cater et al. 2003).

For our change blindness experiment we used stimuli from Ma et al. (2013) who developed a computational model for predicting human performance in this task. We used 10 picture pairs from their original set, 5 ‘easy’ picture pairs with average reaction times of about 5 seconds and 5 ‘difficult’ pairs.

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† only exceptions were when we made use of MTurk Crowd HTML Elements to collect textual input.
with average reaction times of about 60 seconds. These different reaction times makes them interesting and challenging to put on MTurk: would a participant be willing to spend 60 seconds to find a changing target?

![Figure 1. Overview of the changeblindness paradigm, using stimuli from (Ma et al. 2013). The original and modified version are shown in succession with an intermediate gray frame.](image)

Two aspects of the p5.js sketch for the change blindness paradigm are interesting to discuss. First, the filenames are loaded from a CSV file. The filenames are then used to load the images. Reading data from the CSV, as well as loading the images is done asynchronously, meaning that the code will continue to execute, before the data or images have finished loading. While this is useful for normal web pages, in the case of web experiments this can lead to serious issues. To prevent these problems, we use callback functions, which will only execute once the data has finished loading. This is typically needed for experiments with a set of images. Secondly, we used the frameRate() function to control the flicker paradigm. On the original publication (Rensink et al. 1996) an image was shown for 240 ms and the gray blank for 80 ms. Thus, using a frame rate of 12.5 Hz and assigning 3 frames to the image and 1 frame to the blank will result in the required visual presentation. Interestingly, the logging of mouse clicks is not affected by this frame rate setting.

**Bubble View**

BubbleView (Kim et al. 2017) was designed as alternative for eye-tracking studies. The paradigm is simple: let observers try to understand what is represented in an image by sharpening areas of an overall blurred image. Image ‘understanding’ is tested by letting observers describe the picture verbally, while the visual information is quantified by their mouse clicks to sharpen areas. The rationale behind this
approach is that it functionally mimics gaze behaviour: where you plan to look (a fixation) is based on low resolution information from your periphery (i.e. outside the fovea). Recent studies have proposed that blurring may not be optimally representing the loss of peripheral information (Rosenholtz 2016), but computationally much easier than the alternative (Freeman and Simoncelli 2011).

(Kim et al. 2017) showed that click data are very similar to fixation data. We used two images of their data visualisation set to reproduce in our p5.js experiment. The p5.js library allows for basic image filter operations such as blur, and gives access to pixel values through the pixels() command. In our implementation of BubbleView, we showed a blurred version of an image and defined a sharp aperture by displaying the pixels from the (sharp) original around a mouse click location. These are all relatively trivial steps in p5.js. What is furthermore interesting in this example is that we mixed a p5.js sketch with an HTML MTurk crowd element for the textual input. As MTurk is a very suitable solution for collecting textual input, we used that instead of P5. It should be noted that this is primarily practical for a single trial experiment.

**Figure 2.** The BubbleView interface in MTurk. The instruction text, text input and submit button are all in the MTurk HTML, while the image interaction is in p5.js.

We collected 20 clicks per participant, using 9 participants. This is perhaps on the low side, but knowing that the click patterns are rather robust (Kim et al. 2017), we thought this was sufficient. We
used the following criteria for the workers: US, acceptance rate of 95% and more than 1000 accepted HITS.

**Gauge figure attitude probe**

The perception of 3D shape (Todd 2004) is a classic subject in vision science because it concerns the intriguing question of constructing the third dimension, depth, from a flat retinal signal. The reverse process is equally interesting and studied by artist, designers and computer scientists: how to represent a 3D shape in a two-dimensional medium?

An important experiment in the area of 3D shape perception became the so-called ‘gauge figure task’ (Koenderink et al. 1992). It lead to fundamental insights about mathematical transformations describing perceptual ambiguities (Koenderink et al. 2001) and also led to more applied studies on the relation between line drawing technique and 3D shape perception (Cole et al. 2009).

The experimental task is to adjust the 3D orientation of a figure that looks like a drawing pin or thumb tack. An example trial is shown in figure 3. There are various ways to analyse the data, for example simply correlate slant (orientation from screen plane, i.e. outside the screen) and tilt (orientation in screen plane, like the clock pointer) settings. A more complex way is to reconstruct the global 3D surface by integrating the settings because these are essentially the local attitude (the derivative) of the surface. We will not discuss these details further but chose the reconstruction method primarily because it nicely visualises the results. We used (Wijntjes 2012) to setup the triangulation and reconstruct the 3D relief, but the experiment itself fully ran in p5.js. Furthermore, we used a stimulus from (Wijntjes et al. 2012) but with a courser sampling of 64 points, which is approximately recommended by a previous MTurk study (Cole et al. 2009).

A total of 20 workers participated in this study. We instructed the participants to spend about 3 seconds per setting, which would make the experiment last about 3 minutes. Including reading time this would be about 5 minutes. We offered $1 in reimbursement for their time. In this experiment, we used so-called Masters.

**Composition**

In the previous three experiments we focused on well-known paradigms from vision science, but in this last example we want to go beyond these. We will not reproduce known results but rather employ a p5.js experiment to answer a question of artistic composition. Rambrandts’ *Syndics of the Drapers Guild* painting is one of his most lauded works. The unconventional viewpoint, and the dynamics of the viewers’ feeling to interrupt a meeting that just started, is one of the many aspects discussed in art history. Yet, Rembrandt did not immediately achieve this final composition, as x-ray studies have shown (Van Schendel 1956). One of the changes that Rembrandt seem to have made during the process was the position of the servant, the person in the middle behind the others. According to Van Schendel (1956), Rembrandt initially planned to position this person at the far right of the painting. We thought it would be interesting to ask the MTurk crowd for their opinion.

We used photo editing software to cut out the foreground scene and independently the servant. The place of the servant was filled with image elements of the remaining scene as to not give away Rembrandts’ choice. Participants were instructed to position the servant at the location that resulted in
Figure 3. Left the experiment screen is shown with the explanation. In the middle the triangulation can be seen, which is convenient for reconstructing the global depth from the local settings. The blue dots are the barycentres of the triangles and are the sampling points where the gauge figure appeared (in random order). On the right, all settings of 1 observer are shown. Mind that the observers did not see settings simultaneously.

The experiment measures your perception of the shape. Move the mouse behind the image and adjust the figure so that it lies flat on the surface. The rod should stick out perpendicularly (90 degree angle). Spend about 3 seconds (on average) per trial, in the beginning it will take longer, at the end it will take less. Experiment should thus take about 3 minutes.

Instructions: Rembrandt was in doubt where to put this sixth person. We are interested in where you think that person should be. Position him with the mouse to create the best composition. After clicking you can submit the HIT.

Figure 4. Left the original painting is shown: the ‘Syndics of the Drapers Guild’ (1662) by Rembrandt. On the right, the experimental interface is shown. As can be see: the servant is cut out of the original and can be freely positioned anywhere in the canvas.

the best composition. A total of 100 workers participated in this short, single trial experiment, for which they were reimbursed $0.1.
Results and discussions

Change blindness

Four of the 10 images used in the change blindness experiment are visualized in figure 5 with the location of the target, as well as the location the participants clicked. Participants were instructed to find the target change as fast as possible and click where they saw the change. We did not include data from 3 out of 30 participants: their average response time was 3 seconds and click locations seemed random. The clicks for the remaining 27 participants are visualized as the yellow points in 5. To save participants from frustration, if they did not make a click within one minute, we would highlight the target after one minute. Clicks made after this one minute are visualized in red. As can be seen in figure 5, the majority of clicks placed by participants are at, or near the target, with a smaller number of clicks located far from the target. These distant clicks could be the participants wrongfully believing they saw a change, or the participant giving up.

We looked at the reaction times for each trials that qualified the following two conditions: 1) clicks were made within one minute (so as to remove trials in which the correct answer was shown to the participant) and 2) if their click was placed correctly. Correctly here is defined as being within a 0.1 radius from the changing object, based on an image re-scaled to a width of 1 by 1. Note that this is a rather conservative criterion, as in some trials a relatively large object moves around in which where clicks made at the center of the changing object would qualify, but clicks at the edges might not. Performing an independent t-test on the reaction times confirmed that the easy images (\(M = 10.7s, SD = 14.1s\)) were found significantly faster than the hard images (\(M = 25.1s, SD = 23.6s\)), \(t(269) = -6.08, p < .0001\). Ma et al. (2013) found average reactions times of 5.1 seconds for easy images and 58.7 seconds for the difficult images. Thus, our difference is substantially smaller. This is somewhat surprising but there can be various reasons for this difference, for example images size: we used rather small images. Ma et al. (2013) did not report image size but it was likely larger.

Bubble View

We plotted the raw data in figure 6. As the data from (Kim et al. 2017) differed from ours by the number of participants and clicks we corrected for that by visualizing their first 9 observers and 20 clicks in the middle column. It should be noted that this filtering may bias the results because click strategies may depend on either time or click limitations.

The pattern of clicks seems rather similar: participants mostly click on text. In the bottom row the click data also seems mostly similar except that the yellow element seems to attract more attention in our experiment than the original. It is a zoomed in picture of the screen flipping mechanism which is relatively difficult to visually understand (even if you see the sharp version). The yellow part may need multiple clicks to understand its global appearance, while the text between the yellow part and laptop is simply to much to reveal by clicking.

Gauge figure attitude probe

We reconstructed the 3D surfaces on the basis of local surface attitude estimates of 20 participants. The data is shown in figure 7 and ordered on relief depth. What can immediately be seen is that about 35% (the last 7) of the observers did not seem to understand the task. Although there is not much known literature
Figure 5. 4 examples of images used for the change blindness experiment. The top images were designated easy and the bottom as hard, as per (Ma et al. 2013). The red ellipse indicates the change target location. Yellow and red clicks were made by participants. Red clicks were placed after one minute, when the target location was revealed to participants.

about this, we know from experience that the instruction for gauge figure experiments in the lab requires substantial attention. It is seems relatively difficult to understand although showing visual examples generally helps. We have also experimented with instruction videos in other (for now unpublished) MTurk research, which seemed to improve understanding. Taking into account that in this case we only used 64 words to describe the whole task puts the results in perspective: having 65% ’normal’ data is actually above our own expectation.

Although there is further analysis possible, e.g. quantify how integrable (globally consistent) the attitude estimations are (Koenderink et al. 1992) or whether differences can be described by affine
transformations (Koenderink et al. 2001). However, we think it can also be visually inferred that the depth range and global attitude seem to vary quite substantially between observers which is much in line with previous findings. Further analysis may actually reveal these quantitatively but is beyond the current scope.

Composition

The compositional choices of 100 participants are visualised in figure 8. It can be readily seen that 4 horizontal locations dominate. One of them is similar to the actual painting, and the far right alternative is similar to Rembrandts’ under drawing (Van Schendel 1956). Perhaps the other two locations have also been considered by Rembrandt, and maybe there will be art historical evidence for that although we were not able to uncover that.

A natural follow-up question for this short experiment is obviously what the experiential (i.e. perceptual, aesthetic and/or emotional) effect these choices would have.

General discussion

We studied the use of p5.js for visual crowd research. Many functionalities that are needed for visual crowd research are available in p5.js which is likely due to the shared interest of artists, designers and vision researchers in both accuracy and versatility. To demonstrate the use of p5.js we replicated three experiments and piloted a new, fourth experiment. That the results are similar to previous findings may not be too surprising, although two out of three experiments were originally conducted offline. The fact that we find rather similar results adds to the evidence that crowd experiments can replicate lab experiments.
Figure 7. On the left, the stimulus is shown, aligned in a 3D frame where also the subjective surface reliefs are visualised (on the right), which are ordered from shallow to deep. As can be seen in these results, there is quite some variability in the perception for 3D shape, and also in understanding the task (e.g. last 7 observers).

Figure 8. Visualisation of 100 responses of where the servant would result in the best composition. There are clearly 4 dominant horizontal positions with more or less equal probability, except the left most.
More interesting than the experimental results per se is the fact that we demonstrated a simple and effective way to perform a wide variety of visual crowd experiments. With the BubbleView experiment we demonstrated the ability to filter (blur) images and display specific pixel regions (the sharp areas) and how to collect mouse click data. The Change Blindness experiment exemplified how to use shape primitives and how to measure reaction times. The Gauge Figure experiment showed how to use .png images with transparent areas. Overall, this set of four experiments should serve as an adequate basis for developing new experimental paradigms.

While the use of p5.js can also stand on its’ own, we specifically investigated it in the context of Amazon Mechanical Turk. While collecting information about other MTurk studies we noticed that although many researchers share their code publicly, it cannot always be easily re-used. For example, BubbleView (Kim et al. 2017) released their code but not the integration with MTurk because that requires “more complex development settings including a database, a web server, and scripts for automatically managing MTurk HITs.”. These are perfectly valid reasons for not offering a simple way to replicate the experiment on MTurk. But it does increase the threshold for less experienced researchers to use their experimental paradigm.

Similar to the efforts of both Processing and p5.js in making programming accessible to a large audience, our aim was to increase accessibility of visual crowd research. The solution we studied works well but also has its limitations. For example observer management and complex experimental designs may be easier in psiTurk (Gureckis et al. 2016), PsychoPy (Peirce et al. 2019) or TurkPrime (Litman et al. 2017), while fast and accurate graphics may work better with custom code and servers. Also database management, adaptive and automatic HIT creation require more complex solutions. Yet, these trade-offs come with the advantage that designing and running an experiment is almost as simple as copy-pasting a p5.js sketch from the online editor into the MTurk requester portal.

This brings us some last contemplations concerning visual crowd research. Reducing the distance between idea and experiment, between hypothesis and data, does not have much priority in traditional behavioural sciences. In fact, iterative and exploratory research is currently approached with caution due to the replication crisis (Pashler and Wagenmakers 2012; Collaboration 2015). Aside from simple fraud, statistical malpractice etc, a reason for replication failures is that some scientists iterate until a significant effect is found. The problem is that the statistics do not take these iterations into account. Furthermore, the hypothesis can be adjusted post-hoc, i.e. after the results arrived. For this reason, behavioural sciences now make use of pre-registrations: the hypothesis and paradigm should be fixated before running the study. Carefully planning a scientific study goes conjointly with carefully programming the experiment. Then why the need for this sketch-and-test framework we have just been reporting? Because ‘visual crowd research’ both covers a (limited) area of behavioural sciences and at the same time extents towards other disciplines.

Research in vision science is not only steered by preconceived hypotheses but also draws inspiration from informal observations, for example in the area of visual illusions. Exploratory research can precede explanatory research, especially in vision science. The sketch-and-test framework can facilitate this process.

Visual crowd research extents the borders of behavioural science towards areas such as communication design, media studies and (digital) art history. With design, the sketching and testing is conducted on many different levels, from paper prototypes to specific interaction design software such as Sketch or...
Figma. Because p5.js sketches are rather easy to design, integration with a testing platform such as MTurk can be very valuable in the design process. In fact, the Change Blindness and BubbleView experiments we reported are tightly linked with visual information design questions (Varakin et al. 2004; Newman et al. 2020). In areas where large collections of cultural data are studied, such as digital art history, there seems to be a need for annotations (Wijntjes 2018). With simple tasks written in p5.js, annotating collections becomes easy. This would allow for novel ways of analysing visual conventions throughout art history and open up many new and interesting directions of future research.

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Appendix

Here, we report code fragments that are important for running p5.js crowd experiments. If pictures are used they need to be hosted at a server that has the correct CORS settings. Image loading needs to be done in the preload function. Here is an example where one image is loaded. For an example where multiple images are loaded in the basis of the filenames in a .csv file, please see the GitHub repository.

```javascript
let path = 'https://materialcom.s3.eu-central-1.amazonaws.com/bubbleview/stims/';
let imageNameShort = 'wsj104.png';
let imageName = path + imageNameShort;
function preload() {
  image = loadImage(imageName);
}
```

In the online editor, the p5.js canvas is automatically attached to a HTML element. Outside of the editor, this has to be done manually, therefor it is recommended to use the following with the setup() area:

```javascript
canvas = createCanvas(sketchWidth, sketchHeight);
if (!onP5Editor()) {
  canvas.parent('p5sketch');
}
```

where

```javascript
function onP5Editor() {
  return document
    .location
    .ancestorOrigins[0]
    .includes('editor.p5.js.org')
}
```

Now, the ‘p5sketch’ tag can be used in the HTML code, for example like
For data collection it is convenient to use a p5.js table with a manually defined header:

```javascript
let header = ['x', 'y', 'r', 'imageName'];
data = new p5.Table();
for (let i = 0; i < header.length; i++) {
data.addColumn(header[i]);
}
```

To save the collected data, either locally or via MTurk, we used:

```javascript
function finished() {
  if (onP5Editor()) {
    saveTable(outputData, 'data.csv');
  } else {
    experimentOutput = document.getElementById('experimentOutput');
    experimentOutput.value = table2csv();
  }
}
```

Which assumes the following HTML element exists:

```html
<crowd-input hidden name="dataOutput" id="experimentOutput" required>
</crowd-input>
```

The finished function automatically called when the experiment is finished (e.g. when number of trials or total time is reached). As can be seen, we use the onP5Editor function defined previously. If the sketch runs in the online editor, the p5.js function saveTable is used to convert the p5.js Table object to a .csv file. If the sketch runs on MTurk, the p5.js Table is converted to csv text using our custom table2csv function. The csv text is then inserted into an MTurk crowd-input HTML element, which saves the data on the MTurk platform.

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