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# CAN HUGGING A SOFT ROBOTIC CUSHION HELP WHEN YOU FEEL WORRIED?

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Have you ever felt worried or scared about something? That feeling is called anxiety, and it is normal to feel this from time to time. Unfortunately, people can sometimes feel so anxious that it makes them feel sick and stops them from doing things that they enjoy. When this happens, taking medicine or talking to a therapist can help, but it would be helpful to have something to use at home that does not involve medicine. So, we made a robotic cushion to help people when they feel anxious. The cushion is soft and comforting like a pillow or teddy bear, but it also does something special when you hug it to help you feel better: it breathes! In this article, we will explain how we made the cushion and how we tested its ability to help people with anxiety.

## ANXIETY: A BIG CHALLENGE

Life has its ups and downs and it is normal to feel anxious (worried or scared) sometimes. Feeling anxious is your body's way of helping you deal with difficult experiences. If feelings of **anxiety** become too strong or last a long time, they can make you unwell. At this point, anxiety can become a problem and make it difficult to do the day-to-day activities you like. This is called an **anxiety disorder** and it is a type of illness. Unfortunately, anxiety disorders are quite common. A recent study estimates that one-third of all the people in the world will experience an anxiety disorder at some time in their life [1]. That is a lot of people! Luckily, there are medicines and therapies to help, but every person has different needs. Therefore, it is important that scientists keep exploring ways to help people with anxiety. We started our project to find new, non-medical ways to help people with anxiety.

**ANXIETY**

A feeling of worry, nervousness, or unease, which can be mild or strong.

**ANXIETY DISORDER**

When normal feelings of anxiety get stronger and uncontrolled, we can feel it in our bodies, and it often stops us doing what we want to.

## EARLY DESIGN OF THE ROBOTIC CUSHION

Our project involved working as a team made up of a designer, an engineer, a psychologist (someone who studies the brain and behavior) and a roboticist (a person who makes robots). We wanted to make a device to help people with anxiety. In the beginning, we did not know what the device should do or look like. So, we used a method called **iterative design**, which is a process of creating something, testing it with people, then creating a new version based on their feedback, and testing it again. We kept repeating (iterating) this process until we came up with a good final design. In our project, we went through three design iterations.

**ITERATIVE DESIGN**

A method for designing new objects or devices. The process involves multiple iterations (or cycles) of design and testing.

The first iteration was the most difficult because we did not know what a good design might be, so we had to try something out to see if it worked. Just as importantly, if our design did not work, we wanted to find out why.

Using the various skills of our team members, we started by creating early attempts at our device, called **prototypes**. These prototypes took the form of cushions (Figure 1) with robotic parts inside. Each one was designed to create a different calming experience, taking inspiration from existing research and our personal experiences. We ran **focus groups** (groups of people outside of the project team who provide feedback on ideas) to ask people which cushions were their favorite and why. We also showed them different fabrics and colors, and asked them which they would like best on a calming cushion device. The results helped us improve the prototypes. We made five cushion prototypes (Figure 2), which did different things:

**PROTOTYPE**

A first version of a device, to test if the idea works.

**FOCUS GROUP**

A group of people who give feedback about a device or product.

- **Cushion 1** had a balloon inside that inflated and deflated to create a feeling like breathing, inspired by the feeling of cuddling a person or pet.

**Figure 1**

The huggable robot cushion was found to help people to feel less anxious.

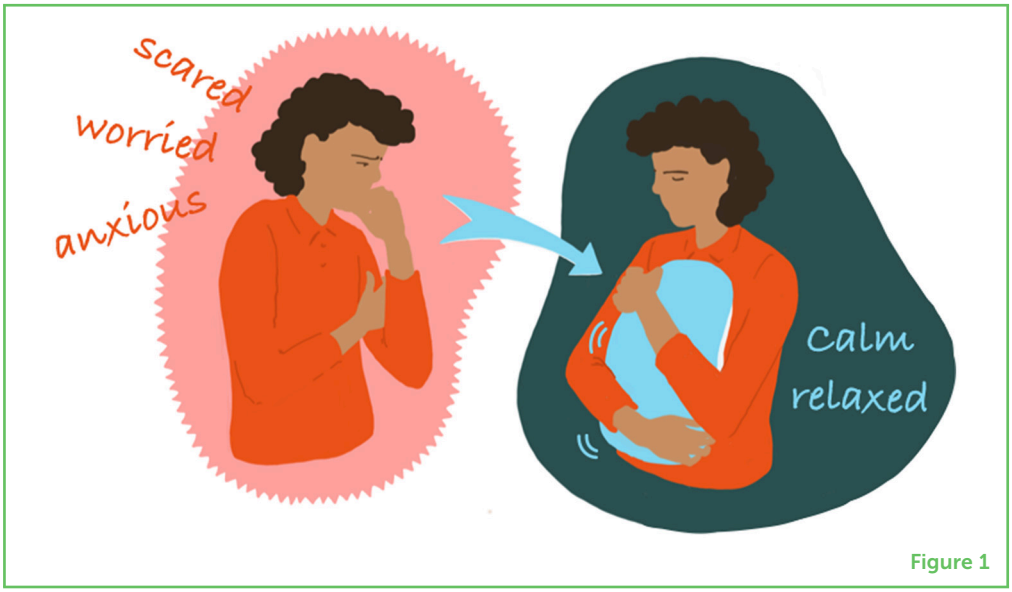


Figure 1

- **Cushion 2** had a moving part inside that created the feeling of a heartbeat, inspired by feeling someone's heartbeat when hugging them.
- **Cushion 3** vibrated gently to create a feeling of purring, inspired by the feeling of stroking a purring cat.
- **Cushion 4** combined the purring and breathing ideas in one cushion.
- **Cushion 5** had rainbow-colored lights inside that slowly rotated and could be made brighter and clearer by pressing your fingers on them.

**Figure 2**

The five cushion prototypes we developed for the focus group all looked the same but did different things.

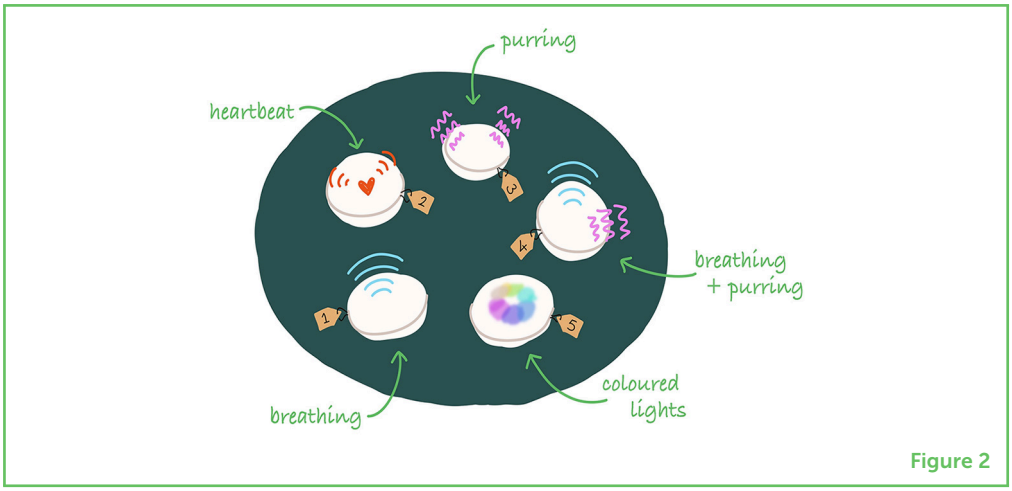


Figure 2

For our second iteration, we ran another focus group asking people which cushion would be best for helping with anxiety. Cushion 1 (the one that feels like it is breathing) received the most positive comments. On average, people gave the breathing-feeling cushion a score of 8 out of 10 for how pleasant it felt, on a scale from 0 (unpleasant) to 10 (pleasant). They also described this cushion as

"calming", "soothing", and "relaxing", which suggested that it could be helpful for reducing anxiety. Therefore, we choose the breathing cushion to explore further.

## FINAL DESIGN: THE BREATHING CUSHION

For our final design, we made a better version of the breathing cushion based on the feedback we got from the focus groups. For example, we made the cushion larger to be more huggable and used soft, blue fabric (Figure 3).

**Figure 3**

Photos of the final robotic cushion.

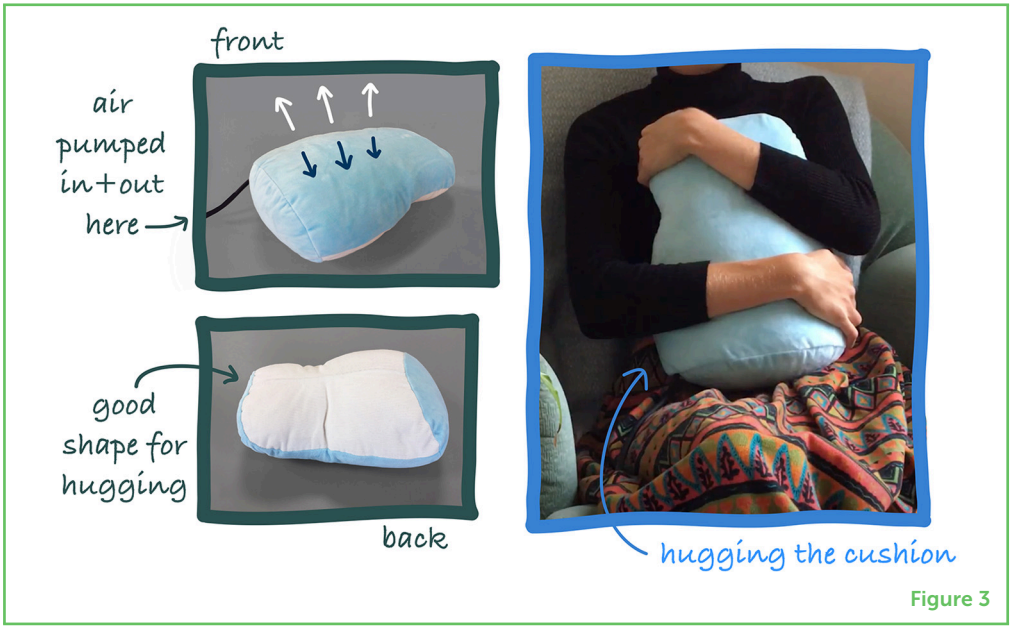


Figure 3

We made a robotic device that could push air in and out of a balloon inside the cushion, to control the "breathing". Because slower breathing is more relaxing, we used a slow breathing rate of 10 breaths per minute. Ten breaths per minute means breathing in slowly for 3 s and breathing out for 3 s—try it for a couple of breaths and see how you feel!

## DOES THE BREATHING CUSHION HELP WITH ANXIETY?

Now that we had our final prototype, we wanted to test whether the cushion could reduce anxiety, so we needed to run an experiment. This experiment needed to do three things. It needed to make people anxious, measure their anxiety levels, and compare the effect of the cushion to something else, so we could see if the cushion reduced anxiety levels.

We made people anxious by making them do a really hard maths test in front of other people. How would you feel if your teacher asked you to stand up in class and answer maths questions?!? Measuring

anxiety is difficult and there are lots of ways to do it. We used a measure of anxiety that asked participants to rate how true the following statements were for them: "I feel calm", "I am tense", "I feel upset", "I am relaxed", "I feel content", and "I am worried" [2]. To compare how effective the cushion was at reducing anxiety, we split people into three groups (called conditions). Condition A experienced the breathing cushion, Condition B experienced a guided breathing meditation (a slow breathing technique that can help reduce anxiety), and Condition C sat in silence without any method to help their anxiety (a **control condition**).

**CONTROL CONDITION**

In experiments a control condition is used to compare a treatment (the experimental condition, e.g. breathing cushion) to a baseline where the treatment is absent (sitting in silence).

**BASELINE**

An early measurement used before an intervention or treatment to check for a change due to the intervention or treatment at a later time.

Our experiment had 129 participants. The steps of the experiment were:

- Step 1: We measured the anxiety levels of all participants (we called this measurement Time1 and it was a **baseline** that allowed us to see if people got more or less anxious than normal).
- Step 2: We made the participants feel anxious by telling them about the maths test they would do in 10 min.
- Step 3: The participants then experienced either the cushion, the meditation, or did nothing, depending on what condition they were in.
- Step 4: After 10 min, we measured anxiety levels again (measurement Time2).
- Step 5: We brought the participants together for the maths test. We expected this to make them very anxious!
- Step 6: After the test, we measured their anxiety levels (measurement Time3).
- Step 7: The participants then experienced the same condition as before: the cushion, the meditation, or nothing, for 10 min.
- Step 8: Afterwards, we measured anxiety levels for the last time (measurement Time4).
- Step 9: We thanked the participants for taking part and told them about our research.

## RESULTS OF THE EXPERIMENT

At that point we had lots of data! First, we checked that the participants in the three conditions all started with similar levels of anxiety (measurement Time1). They did, which meant we could compare their other anxiety measurements. We also checked that the maths test made participants feel anxious, to make sure that our method worked. It did—participants anxiety levels were much higher after the maths test (Time3) compared to the baseline (Time1).

Then we came to the main findings. We checked measurement Time2 and found an exciting result: the people who hugged the breathing cushion had much less anxiety than the people who sat in silence. This means that the breathing cushion helped people to feel less

anxious when they were about to do the maths test! We checked the measurements for the people who did the meditation and found that it also helped reduce their anxiety.

These findings suggested that the breathing cushion can help when someone is feeling anxious.

## HOW CAN WE HELP MORE PEOPLE WITH ANXIETY?

Our experiment showed that the breathing cushion could be a useful tool for helping people when they feel anxious. Not everyone wants to take medicines, and meditation can be difficult because it takes focus and practice. But hugging a cushion is easy! And it is possible that a person could use the cushion while doing other things [3]. By continuing to do more research like this, we can help people who have different needs or preferences for treatment. We hope that the breathing cushion can help many people when they feel anxious. What do you think—would you like to have a breathing cushion to hug when you feel worried about something?

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## REFERENCES

1. Bandelow, B., and Michaelis, S. 2015. Epidemiology of anxiety disorders in the 21st century. *Dialogues Clin. Neurosci.* 17:327–35.
doi: 10.31887/DCNS.2015.17.3/bbandelow

2. Marteau, T. M., and Bekker, H. 1992. The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory (STAI). *Br. J. Clin. Psychol.* 31:301–6. doi: 10.1111/j.2044-8260.1992.tb00997.x
3. Haynes, A., Kent, C., and Rossiter, J. M. 2024. "Just a breath away: investigating interactions with and perceptions of mediated breath via a haptic cushion", in *TEI '24: Proceedings of the Eighteenth International Conference on Tangible, Embedded, and Embodied Interaction*, 36, p. 1–19. doi: 10.1145/3623509.3633384

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The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



## YOUNG REVIEWERS

**ÇAĞAN, AGE: 11**
My name is Çağan. I am in fifth grade at Volkmorade Grundschule in Germany. Some of the things I enjoy doing are reading, playing football and basketball, science, ancient languages, and computer science. I love reading adventure novels, especially the Harry Potter book series. I played the piano for four years, now I am interested in other instruments. I love nature, plants, and animals.

**ÇAĞLA, AGE: 9**
My name is Çağla, I am in the 3rd grade at Wilheim Gymnasium in Germany. Things I like to do: gymnastics, reading, painting, and listening to music. I enjoy science fiction and fantasy books. I did ballet for 3 years. I am playing piano. I enjoy playing games. I love nature, animals, and plants.

**TRILOK, AGE: 11**

A passionate reader with a keen interest in automobile technologies, fascinated by the intricacies of physics and mathematics. Achieved high distinction in both mathematics and English Australian IBT tests for consecutive years. A curious footballer who constantly explores the inner workings of cars.

## AUTHORS

**ALICE HAYNES**

Alice is a roboticist who was working at the University of Bristol and now works at Saarland University in Germany. She makes robots out of soft and squishy materials, that often do not look like what you think a robot might look like! She loves sewing and often makes robot devices with fabrics (for example in cushions, toys, or clothing). She wants to make devices that are easy and comforting to use and that help people to feel better. *alicehaynes22@gmail.com

**JESSICA L. FIELDING**

Jess is a cognitive neuroscientist in the School of Psychological Science at the University of Bristol. She is interested in how people feel (mental health) and how those feelings impact their daily lives. She is also interested in what happens in people's brains when they feel certain ways. She wants to find accessible ways to help people when their feelings make everyday life more challenging, and she thinks that cuddly robots are a great way to help people. Who does not want to cuddle a robot after all!

**ANNIE LYWOOD**

Annie is a designer who makes sensory wellbeing products to soothe and comfort people. She likes to combine textiles and creative technologies to create interactive and huggable cushions of all shapes, colors, and sizes. She is particularly interested in creating accessible and sustainable products with style and character.

**CHRISTOPHER KENT**

Chris is a cognitive psychologist in the School of Psychological Science at the University of Bristol. He studies how people see, hear, and feel the world around them (perception) and how they store and retrieve those perceptions at a later time (memory). He thinks robots are cool and likes to hang around with engineers who make robots. He wants to see how people respond to robots, to make them better. He has three boys who think his job is boring—they are much more interested in the robots.

**JONATHAN ROSSITER**

Jonathan is an engineer who makes many different types of robots. Some are biodegradable and can be safely thrown away after use, some are designed to go into space, some go inside the body to help treat illness, and some are even edible and made out of food! He wants to help make a world where robots enhance every part of our lives.