BackTrack

Team Members

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Design Problem and Solution Overview

Except for sleeping, people spend most of the time standing up such as walking and sitting on the chair. The accumulation of how one stands up has great impact on the future of the person. Posture is one of the biggest factors which affects various elements: health, mental, communication and outlook. Bad posture causes difficulty in respiration because there is smaller room for lung compared with that in good posture. Besides, bad posture imposes burden on spine and result in back pain. Not only physical problem, it brings mental problem. It is known that people with upright posture have more positive emotion than those with slumped posture[1]. Posture also affects impression from other people. People with good posture looks confident and energetic but those with bad one opposite. Because of these advantages, people try to keep posture good. However, it is difficult to always have good posture as it is shown that nearly 90 percent of the United States' population lean forward with their neck[2]. This project is aimed at helping people to get the habit of keeping good posture and solve health problem and improve appearance.

Our solution is called BackTrack, a wearable wristband that connects to existing smartwatches like the Apple Watch. It uses sensors, which are connect to the user's clothing, to tell what kind of posture they have. When the user calibrates the device at the beginning of the day to their "good" posture. Throughout the day, as they begin to slouch and develop bad posture, the BackTrack device will sense this and, if maintained for a duration of time, will gently squeeze the user's wrist to bring their attention to their subconsciously bad posture. If for any reason the device incorrectly corrects the user, they can help "train" the device by providing feedback. The BackTrack allows the user to participate in a wide range of activities, rather than keeping them tied down to a particular desk or computer. They can also look at their data through a web or phone application, to learn about what might be triggering their bad posture.

Design Research Goals, Stakeholders, and Participants

Design Research Participants

A. Fly on the Wall (Figure1, Figure3)

We utilized three different techniques in conducting research. For the first, "Fly on the Wall," we went to five different locations in the Seattle area: the University District branch of the Seattle Public Library, Odegaard Library (4th floor), Kaiser Permanente (formerly Group Health), the Husky Union Building, and the Northgate Mall Food Court. In total, we observed approximately 30 participants, ranging in duration from a few minutes to several hours. Most of the observations took place while people were seated at tables and desks. Because we didn't

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[1] Nair S et al. Do Slumped and Upright Postures Affect Stress Responses? A Randomized Trial. Health Psychol. 2015 Jun;34(6):632-41.

[2] http://www.goupstate.com/news/20100511/experts-say-posture-matters-the-good--and-the-bad

interview the participants, we don't know their exact ages, but we estimate they ranged from early 20s to late 40s.

B. Experience Sampling

We performed experience sampling to learn if certain temporal, spatial, or social contexts influence posture. We will ask participants 4 times per day where they are, who they're with, what they're doing, and how they would rate their posture on a 3-point scale (1=bad, 2=neutral, 3=good). For our experience sampling we had 5 participants:
1. Female, 26, Medical School Student at Saint Louis University
2. Female, 24, American Studies Student at UW
3. Male, 21, American Studies Student at UW
4. Male, 18, Computer Science & Engineering Student at UW
5. Male, 18, Computer Science & Engineering Student at UW

C. Contextual Inquiry (Figure 2)

For our contextual inquiry, We covertly videotaped participants working at a desk for as long as it takes for them to adjust their posture in a negative way. We then showed them the videotape and ask them why they made that adjustment, what they were doing, and how they were feeling in that moment. We had 2 participants:
1. Male, 29, Software Engineer from Seattle, WA
2. Female, 23, Bioengineering Student at UW
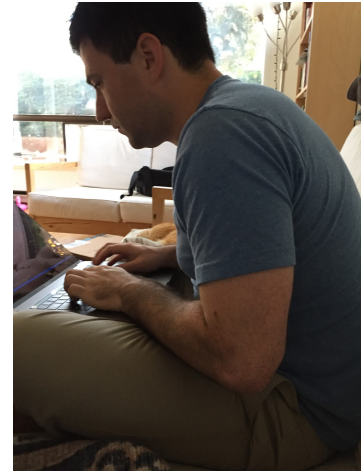

Figure 1: Fly on the wall at HUB

Figure 2: Contextual Inquiry

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Figure 3a.,3b.,3c.: Fly on the Wall at Odegaard Library

Design Research Results and Themes

Summary of Key Findings and Takeaways

To learn more about how people develop bad posture, we conducted mixed methods design research with approximately 30 participants using "fly on the wall" observations, 5 using experience sampling, and 2 using contextual inquiries. We observed that bad posture is developed unconsciously and over time while performing sedentary work, such as reading on a computer screen. Thinking intently about something tended to cause a shift in posture, such as leaning an arm on a desk or shifting feet under a chair. The range between good posture and bad posture narrows when standing, and doing stressful work seems to have a negative impact on posture. Finally, although the position of participants' necks and backs are the most noticeable elements of poor posture, poor posture in the lower body might contribute indirectly to bad posture habits over time.

Design Research Themes

Several high-level themes emerged when reviewing our data. Most interestingly, none of our participants were really conscious of their posture or why they were changing positions. People don't know they have poor posture until it's too late.

We learned that our participants' posture was generally worse when they were working in front of their computers (often on school work). When people were thinking intently about something, they often leaned their arms on the desk, twisting their body forward in their chair. On the other hand, posture was best when participants were more relaxed and doing casual activities, such as watching TV or shopping. In general, people actively using a device with a screen (smartphone, laptop) had much worse posture.

Also, postures help people to do what they want. One participant had some patterns of posture, which corresponds to what she is doing. She rest her chin in her hand when she was thinking and used both of hand when she needs deeper thinking. She changed the posture to refresh when she was stacked to the problems. Besides, she made good posture to wake herself up.

We also noticed that a person's lower body, in particular the position of their legs and feet, had a large influence on overall posture. Those who sat cross-legged or tucked their feet under their chair would often have bad back posture as well. Finally, there was a decreased range between poor posture and good posture while people were standing. These themes suggest that our design should be intended for people who do mostly sedentary work sitting down, and because posture is mainly subconscious, we should try to avoid designs where users have to actively remember to log themselves. It might be fruitful to focus on designs that improve a person's lower body posture, which could have an indirect corrective effect on their overall posture.

Answers to Task Analysis Questions

We struggled at first with developing our tasks, as posture is different from other tasks in that it is constantly performed (either good or bad), subconscious, and secondary to whatever other task the user is performing. After a few iterations of our task list, we came up with tasks and subtasks that takes into account the variety of causes of bad posture, different activities that a user might do while maintaining posture, and the degree to which posture is a primary or secondary task.

Posture Tasks + Subtasks:
1. Trying to look confident with good posture
2. Avoiding back pain/stiffness when sitting Trying to become aware of daily "posture creep"
3. Correct the misunderstanding toward "good posture"
4. Discovering which activities trigger posture habits to form
5. Need to get close to the monitor to get focus on contents of the laptop (While using a laptop, avoid leaning in too closely see contents of laptop)
6. Adapting to different activities (using cell phone standing vs. using desktop seated)
7. Prevent interference with critical tasks

Who is going to use the design?

People who spend a lot of time seated and working in front of a screen (college students and office workers) are probably going to be the main users of the design. We noticed that this

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seems to be where the worst posture tends to occur. We also plan on narrowing our focus to young adults, who we observed having consistently poor posture. In school and at work, young adults spend an increasing amount of time in front of a computer screen, which puts them at risk for back pain and other health issues[3].

What tasks do they now perform?

Our participants tended to start with good posture and acquiesce into poor posture over time. This is mostly an unconscious choice but stems from discomfort while sitting and working with objects whose usability depends on bodily position (e.g. looking at a computer screen). Their bad posture occurs within the context of other more pressing tasks they are accomplishing, such as studying or programming, which takes up their attention.

What tasks are desired?

We aim to inspire awareness of our participants' posture. Posture, being a secondary task for people most of the time, isn't something people have the mental energy to be constantly paying attention to. People desire good posture to look more confident, and to avoid health problems from developing. Our participants had tasks that needed to be accomplished (studying, programming, reading), and so they need to not have to consciously focus on posture because that would distract them from these higher prioritized tasks.

How are the tasks learned?

The tasks are learned by "muscle memory" and the subjective comfort of their bodily position. Bad posture can be comfortable in the short term, but it has difficult-to-notice, long-term consequences on health and energy expenditure. Because maintaining posture is a subconscious task and not a primary activity, it can be incredibly difficult to learn to have good posture. To address this, our design will need to be able to make people consciously aware of their posture.

Where are the tasks performed?

We found that generally the people we observed (aged 20s to 30s) had much worse posture when working in front of their screen at their desks. Although most of our research observed our user group doing these kinds of tasks, there were also a variety of other activities where posture might be a problem – reading, hanging out with friends, or watching television.

What is the relationship between the person and data?

Right now people are typically not aware of what posture they have, or when they shift positions. So there is effectively no real relationship between people and their "posture data."

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[3] Canadian Chiropractic Association Staff Team. (2016). Looking Ahead: Millennials and Long-Term Health. Retrieved from https://www.chiropractic.ca/blog/looking-ahead-millennials-and-long-term-health/.

One type of information that might indicate to individuals that they have poor posture would be back or neck pain. Some specific postures may have relationship with what they are doing and what they are feeling now. Also, participants should have feedback about how long they stay in a certain position.

What other tools does the person have?

Typically the people we observed and interviewed were working with their laptops, pen and paper or looking at their phones, putting laptops on the desk and sitting on the chair. The type of chair that they are sitting in seems to make a difference in their posture- for example, a chair that leans back is better for back posture but worse for neck posture, and a chair that is very deep forces the sitter to posture themselves on the edge, where they seem more likely to lean forwards towards their work. Other tools, such as a computer keyboard also seem to make a difference, for example, one handed typing leads to worse posture than two handed typing.

How do people communicate with each other?

It's a bit difficult to answer this question in the context of posture as a "task", but being with friends and other people definitely did affect posture. We found that people walking around and chatting with friends typically had good posture, but it varied more for people chatting with friends while sitting down. For example, people using large gestures while talking to friends tends to have good posture because they need to open up.

How often are the tasks performed?

Our design would need to be able to be used on a daily basis, as the work we observed our participants doing was typically their regular work (homework, programming, etc.). The task of maintaining good posture should be a task that is constantly performed. By "performing" good posture everyday, people would be able to use and develop the muscles that are required.

What are the time constraints on the tasks?

One constraint is that because posture is typically at its worst while people are working, our design would need to be relatively unobstructive and not distracting, so consciously interacting with our design would need to not take more than a few minutes per day.

What happens when things go wrong?

We found that typically posture worsens significantly when people look down at their phones, or lean on something (e.g. while thinking hard about things) while looking at their laptop screens. In addition, we saw people also have worse posture while sitting in different positions (cross legged, tucking feet under chair, etc.). This can lead to, "imbalanced body alignment,

strain on ligaments and muscles, chronic pain, injuries, impingement, low back pain, neck pain, hip pain, joint stiffness and muscle tightness"[4].

Proposed Design Sketches - "3x4"

Design 1: Laptop Webcam App (Figure 4)

High-level Description

While sitting in front of your laptop, the app will run and poll your webcam to determine your posture. If you currently have bad posture, the app will notify you by dimming your screen a customizable amount until you sit up. Posture status and times will be logged by the app for later review.
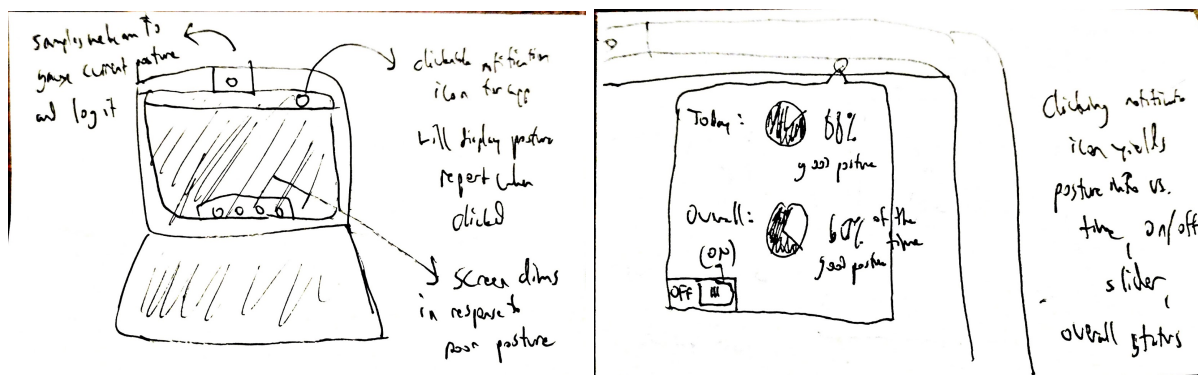
Sketches

Figure 4: Laptop Webcam App

Supported Tasks

- Task 1: **Trying to look confident with good posture.** By reminding of posture when sitting in front of a laptop, you can show greater confidence.
- Task 2: **Avoiding back pain/stiffness when sitting.** By getting posture reminders when sitting in front of a laptop, you are more likely to adjust your position to sit up straighter.
- Task 3: **Trying to become aware of daily "posture creep".** Stop posture creep by notifying immediately when posture is slipping, so it's corrected immediately
- Task 6: **Need to get close to the monitor to get focus on contents of the laptop.** The app will detect when you are leaning towards the screen and darken the screen in response to notify you of poor posture.

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[4] Olgadez, N. (2015). Expert alert: What is a healthy posture and how to maintain it. *Mayo Clinic News Network*. Retrieved from
https://newsnetwork.mayoclinic.org/discussion/expert-alert-how-to-maintain-a-healthy-posture/.

- Task 8: **Prevent interference with critical tasks.** Since the notification is done via dimming the screen, which is relatively non-invasive, work currently being done will not be interrupted.

Design 2: Wearable Device (Figure 5)

High Level Description

This design includes sensors that attach to the user's clothes. These sensors monitor the posture of the user, and communicate it to the wearable device located on the user's wrist. If the user has good posture, the wearable provides positive, passive feedback. When the sensors detect that the user's posture has deviated a certain amount from what is considered acceptable, the device puts pressure on the wrist, lightly squeezing. The wearable also could connect with an application, accessible either by mobile or on desktop. Here, users can access visualizations about how their posture has been over time, and whether it has improved.
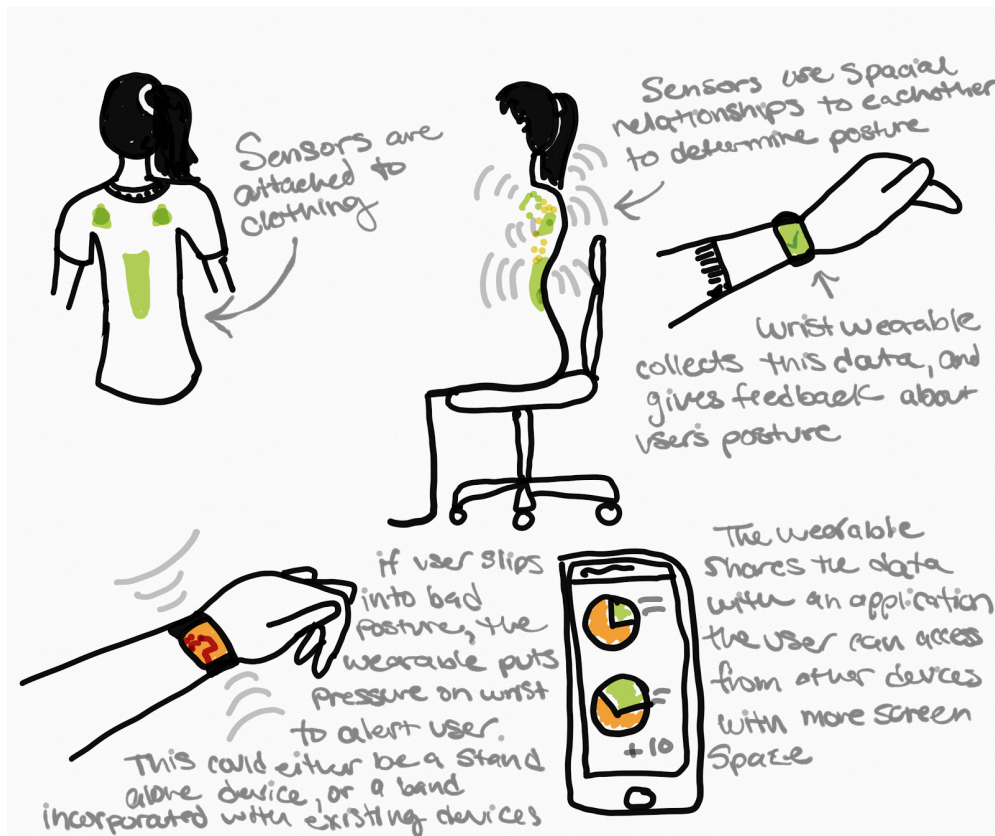
Sketches

Figure 5: Wearable Device

Supported Tasks

- Task 1: **Trying to look confident with good posture.** By reminding of posture such as before presentation, you can be aware of being good posture
- Task 2: **Avoiding back pain/stiffness when sitting.** By reminding unchanged (bad) posture during desk work, people can avoid back pain/stiffness of back and shoulder
- Task 3: **Trying to become aware of daily "posture creep".** By recording the posture using the sensor, user can see the changes of the posture as time passes
- Task 7: **Adapting to different activities.** User can use this device in any situation because the device is designed to be wearable.

Design 3: Posture Light (Figure 6)

High-level Description

Some combination of a "smart" lumbar support cushion, tilt-sensitive wearable device, and indicator device will provide real-time feedback about posture. The lumbar support cushion will be embedded with sensors that can estimate a person's upper body tilt angle, which has a large overall effect on bodily posture. This angle will be logged over time as a "posture score", which can be reviewed at any time in an online web app. The web app will also flag the daily best and daily worst posture score, and prompt for more information about what was happening during the day at that time. A bluetooth-connected indicator device can be connected that provides real-time feedback about posture in the form of gradiated colors of light. Colors will correspond to different quality levels of posture, and additional positive reinforcement can be provided in the form of special colors that activate during daily best posture scores and/or personal record durations of good posture. These devices will encourage good posture without interfering with daily tasks.
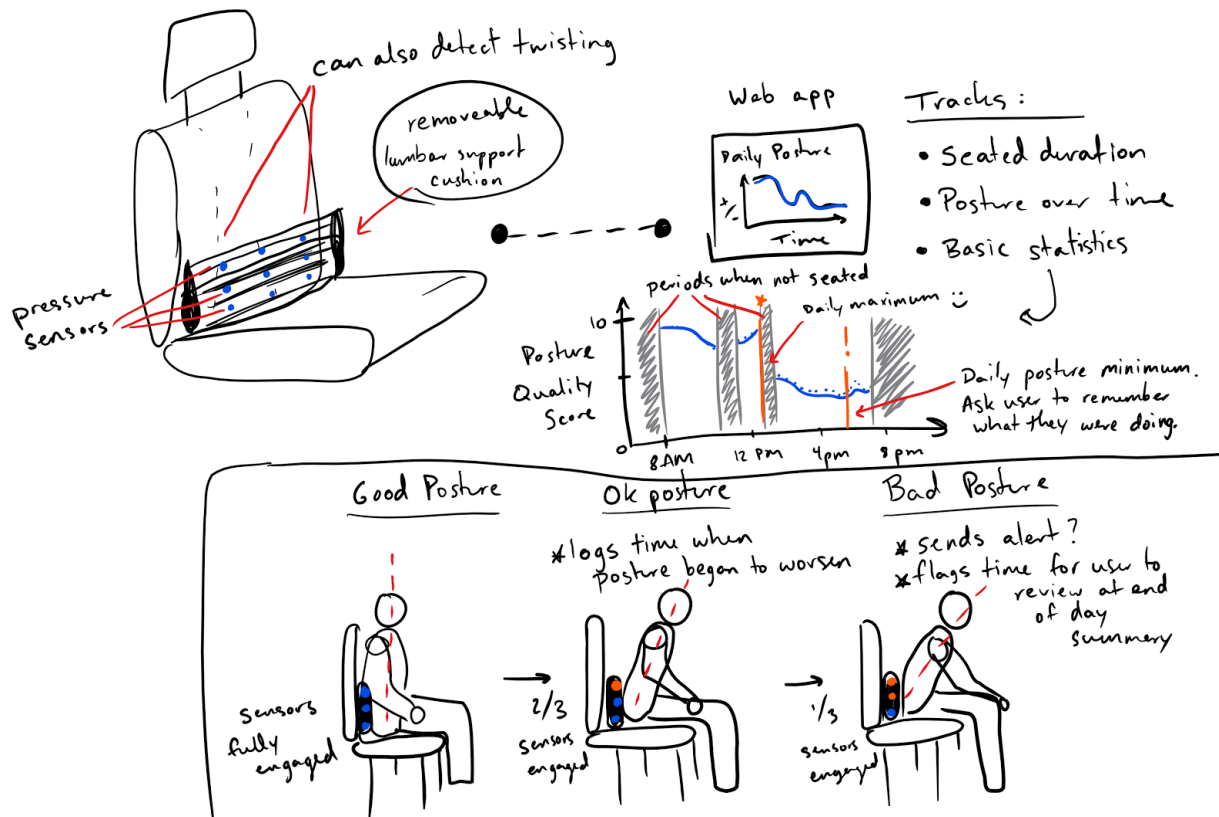
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Sketches

Figure 6a: Posture Light (record and sensing)

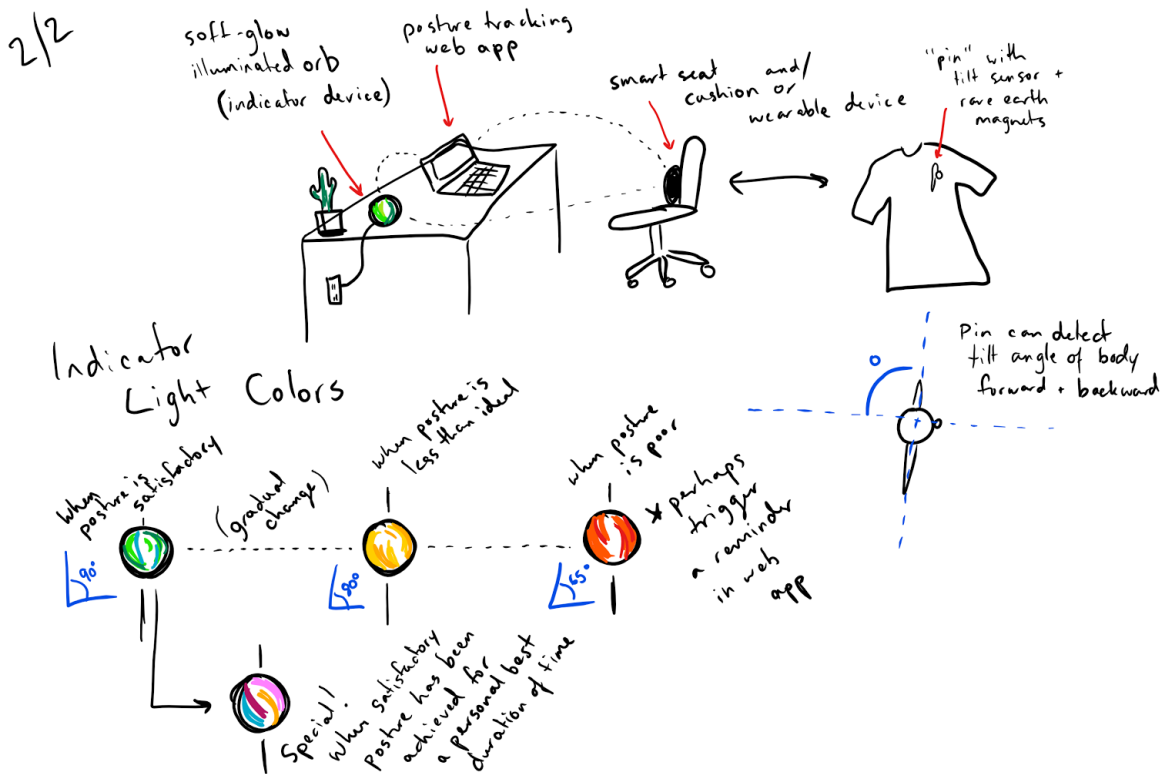Ashley Lindsey, Daniel Hua, Mike Stepanovic, Yuqian Sun
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Figure 6b: Posture Light (output)

Supported Tasks

Task 1: **Trying to look confident with good posture.** Refer to the indicator device throughout the day to get feedback about current posture and corresponding body language.

Task 2: **Avoiding back pain/stiffness when sitting.** Using the positive reinforcement features of the web app, try to set personal best records for good posture, which will strengthen back muscles that contribute to stiffness.

Task 3: **Trying to become aware of daily "posture creep".** Use the indicator light as a reminder to maintain good posture.

Task 5: **Discovering which activities trigger posture habits to form.** Rather than logging posture quality throughout the day, use the web log to identify dramatic posture changes that happen and think back to what might've caused them.

We decided to select our second design, the wearable posture reminder. It will support two primary tasks: 1) trying to become aware of daily "posture creep," and 2) adapting to changing activities. We selected the first task because our research revealed that bad posture is a very subconscious habit; we hope that by bringing it into the conscious mind, it will help people learn to maintain good posture. Our second task is important because our users are not always going to be in the same location or doing the same things. We have decided to narrow

our focus on work done in front of a screen, but even within this niche we found a wide diversity of activities and situations our users might experience. Our experience sampling in particular supports this idea. We chose the wearable posture reminder because it was the only design that supported both the first task as well as the second.

Written Scenarios - "1x2"

Scenario for Task 1: Trying to become aware of daily "posture creep". (Figure A)

Tom has a back pain and he attributes it to bad posture. Therefore he buys BackTrack, which is a new product intended to help people to keep good posture. He sticks the sensors to the underwear he is going to wear today as the guide shows and wears T-shirt on it. Then, he uses smartphone application to calibrate his posture. Then, he puts a watch-shape device on his left wrist and push the button to start recording. He spends his college life as usual, but when he is studying at the library, the device starts to squeeze his wrist. He finds he became bad posture. The device just tells him bad posture but no one around him notices it. In the evening, he comes back to home and stop recording with button of the device. Then check the record using the application. He finds that he tend to be bad posture 15 minutes after he starts sitting. By using BackTrack, he naturally get the custom to be good posture by quiet notifying and knowing his habit.

Scenario for Task 2: Adapting to Changing Activities. (Figure B)

Joe sits in his favorite chair, attempting to slog through a long reading assignment he has due tomorrow. He's been reading for several hours, and slowly but surely he begins to lean forward into a slouch without even realizing it. His BackTrack device gently squeezes his wrist after he slouches for more than a few seconds, and Joe remembers to sit up straight. His roommate yells for him to come into the other room, and so Joe gets up and walks over. The device recalibrates as he gets up, sensing that he is now standing. As he talks to his friend about what to make for dinner, he starts to slouch again. The subtle squeeze from BackTrack reminds him to stand up straight.

Storyboards of the Selected Design

Task1: Trying to become aware of daily "posture creep"

Figure A: Trying to become aware of daily "posture creep"
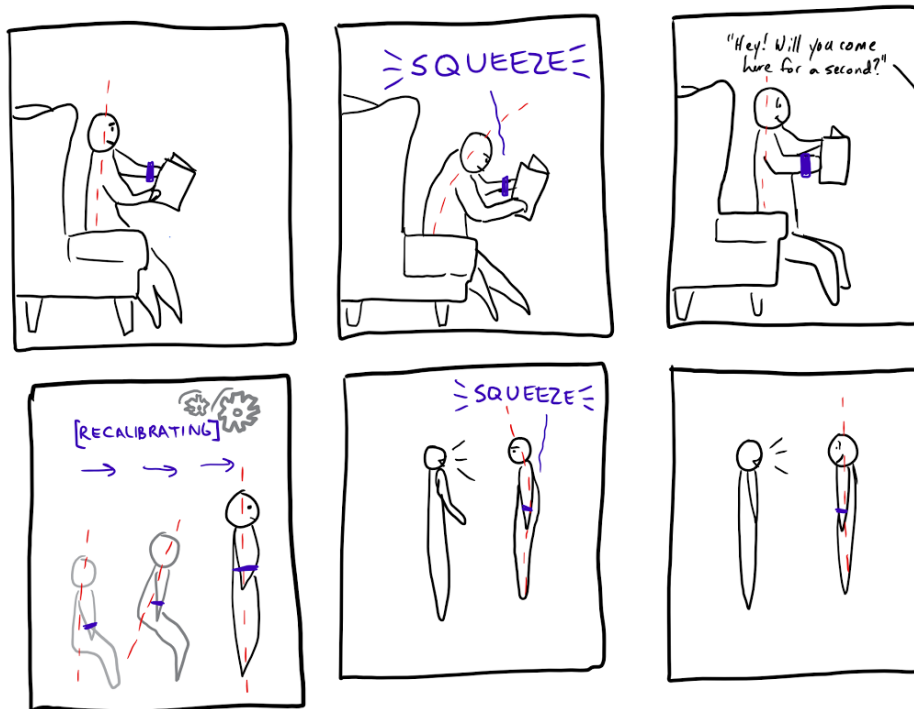
Task2: Adapting to different activities (standing vs. sitting

Figure B: Adapting to different activities