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## **Mobilizing Skin Care: Measuring and Tracking External Conditions with Light Emitting Diodes**

**Stephen J McNeill**

Department of of Communication, Kennesaw State University, USA

Email: [smcneil2@kennesaw.edu](mailto:smcneil2@kennesaw.edu)

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### **Abstract**

Light emitting diode (LED) technology allows users to monitor their indoor and outdoor environments while engaged in various tasks. LED has long been touted for its direct benefits to the skin; now, new LED technology is monitoring many external conditions that directly relate to human skin and respiratory health. My Skin Track UV, from La Roche Posay, is an integrated near-field communication (NFC) app. The light emitting diode (LED) acts as a detector to capture UV light. The battery-free, water-proof LED is worn on clothing and the energy is read by transferring data from the sensor to a smartphone via NFC technology. Based on one's UV exposure and other environmental factors, the app uses a closed-loop, proprietary algorithm to issue a notification when environmental exposure is at a level that contributes to the users' specific skin concerns. Skin cancer is the most common form of cancer in the United States and is the easiest to prevent. My Skin Track UV measures UVA and UVB exposure, noting the maximum percentage of sun-stock – the recommended maximum daily allowance of UV based on skin tone and the UV index. It also tracks pollen, pollution, temperature, and humidity. This paper discusses application of LED and NFC technology and reviews similar skin care applications and health education, including uses and gratifications. The associated paper features background technological research behind the evolution of smart-phone UV skin monitoring. The paper also includes results from product demonstration.

**Keywords:** Light emitting diode, near-field communication, UV exposure, biometric user interfaces, wearable technology

## Literature Review

### Technology

The technology involved in My UV Skin Track from La Roche Posay concerns two factors: Light Emitting Diodes and Near-Field Communication. Further, the battery-free device communicates with the companion app housed on the end-user's smartphone. The app also integrates with Apple HealthKit for further convergence. Using a small clip, the user wears the device on the outside of their clothing while engaged in day-to-day activities. Users wore previous versions of this sensor with adhesive on a fingernail.

My Skin Track UV measures UVA and UVB exposure, noting the maximum percentage of sun-stock, which is the recommended maximum daily allowance of UV based on skin tone and the UV index. It also tracks pollen, pollution, temperature, and humidity. Actual end-user exposure updates by touching the device to the smartphone with the downloaded app. This differs from a constant Bluetooth connection. Other environmental factors are obtained via geolocation and they are aggregated from weather services, most notably Weather Channel. Finally, the app contains skincare advice based on self-reported skin tone and sensitivity, as well as activity monitoring during outdoor pursuits such as jogging, and trends based on the user's previous behavior patterns.

Before the My UV Skin Track launch, there was a prototype (My UV Patch) that La Roche Posay designed for families with children. It was a device for children that was not worn, but rather it was a patch attached to a child's wrist to aid in sun exposure. The parent or guardian could use the companion app to monitor external conditions while their children played outdoors or otherwise going throughout the day. The patch was designed to be thin, water resistant and last for multiple uses. It was also touted as something to help educate families concerning sun exposure and other environmental conditions that could affect skin and respiratory health.

### Background of Light Emitting Diodes

When thinking about Light Emitting Diodes or LEDs, most people recall efficient replacements for incandescent light bulbs or, in a media production environment, the cool-to-the-touch film lights that can light up a stage, scene, or set.

LED technology can also act as a detector to capture UV light. While now a mainstay in many homes, its history is traceable back over a hundred years. Henry Round was an early pioneer in radio and received numerous patents before stumbling onto LED light. At the time the technology was called Electroluminescence; Round reported

that certain substances, when passed through “cat whiskers” (a now-obsolete electronic component), gave off light. He subsequently published his report in 1907.

### **Background of Near-Field Communication**

Most smartphone users have used Bluetooth technology for wirelessly listening to music, connecting headphones, and using activity trackers. Adding to the connectivity options, most modern smart devices come equipped with Near-Field Communication (NFC). Beginning as a payment mechanism in Japan in 2004 administered by Sony, Nokia, and Philips, NFC has become an integrated connectivity technology with many other applications. When an associated smartphone comes within 1-2 inches of the device, the connection occurs. Originally designed without batteries, NFC had strict security and production protocols from the outset owing to financial transactions and building access being an option for users.

### **Other Skin Care Applications**

Skin care and technology have been growing hand-in-hand for many years. Large corporations, such as Clinique, offer “smart” skin analysis via their website as well as in-person. Another cosmetics corporation, Neutrogena, in partnership with FitSkin, released Skin360 in 2018 for certain iPhone models. It works by connecting over the phone’s camera lens. After connecting the device and launching the app, the Neutrogena Skin360 measures pores, fine lines/wrinkles and moisture using eight on-board LED lights directly against the skin. Trove is a free app for iPhone and Android that addresses all superficial skin concerns using smartphones’ built-in cameras. With no additional hardware or software costs, Trove analyzes skin texture, pores, fine lines, and spots (acne). Trove also lets the user self-report the products they are using during skin analysis. There are also points one can earn by doing skin reports, gamifying the process. While users may take selfies regularly, smartphone cameras have come to serve yet another purpose.

### **Methodology**

#### **Location of Study**

The current study was conducted on campus at Kennesaw State University, as well as online through computer-aided research. This location was chosen because the researchers conducting the study all attend Kennesaw State University, making participation more accessible for outdoor trials.

#### **Research Design and Sampling Procedure**

The study took place for 30 continuous days from May 1-30, 2019 – a timeframe intentionally chosen because it is long enough to chart progress and because the spring season means sun exposure is more relevant than the cooler seasons before it.

## Data Collection

Data was gathered for specific themes and trends among different criteria, as well as commonalities among chosen apps. The data gathered is qualitative, but there is also quantitative data present. Certain measurements were made regarding specific Uses and Gratifications.

## Data Gathering Instrument

1. **Privacy:** within Terms of Service.
2. **Efficacy and Usability:** ease of use.
3. **Comparison to science:** sun exposure measured versus actual scientific weather forecast during use.
4. **User Education:** measured data presented to users during use.

## Data Analysis

Focusing on each measurement, the current study analyzed and organized the gathered data into specific categories to best examine the effects of mobile skincare applications; it also examined negative and positive data in relation to the total testing period spent using the mobile application. In this process, the researchers also recognized and charted relevant patterns and themes to present the study's results.

## Results

Focusing each measurement, the researchers analyzed the gathered data and organized it into specific categories to best examine the effects of mobile skincare applications. This process also involved examining negative and positive data in relation to the total testing period involving using the mobile application, May 1-30, 2019:

**Privacy:** including Terms of Service.

Positive outcomes:

- My Skin Track UV does not require users to sign up, provide contact information, or enter into any agreement with respect to email or other contact data. A user can employ the hardware and app as a guest with no sign-up necessary. This is important when considering privacy and access to personal information that the service is capable of gleaning.
- La Roche Posay states that it does not sell personal data that the device or app collects, and that they require the same of any third parties.
- Potential negative outcomes:
- My UV Patch will not work or operate in any way unless the user signs up with personal email and enter into the Terms of Service.

### **Efficacy and Usability:** ease of use.

#### Positive outcomes:

- My Skin Track UV has a list of tasks that the user can select before undertaking activities, such as running outdoors. This tracks the activity and offers a forecast. Logging an activity allows the algorithm to gauge a highly accurate reading of the user's UV exposure.
- The app can also integrate with Apple Health, providing even more detailed health information for the user.
- The solar powered hardware does not need any extraneous power to operate.
- My UV Skin Patch is set up specifically for children and parents, and so the app features avatars that direct a user according to the activity they choose. The built-in AI assistant Helio or Helia (the user chooses) direct the user, through text, to connect new patches when the app launches.
- When communicating with My UV Patch, it is set up like a chat room. It also integrates geo-location and uses data to present Weather Channel with the most up-to-date information based on the user's location.
- The app features include basic functionality, such as the day's UV index, hyperlocal weather and humidity, and patch setup. The UV index tab of the app also directs the user to recommended skincare products (all products sold by the manufacturer of the app, La Roche Posay).

#### Potential negative outcomes:

- La Roche Posay suggests scanning one's NFC hardware at least twice a day, and ideally every two hours if outdoors, which may prove potentially inconvenient for active users. Accordingly, the app reminds the user every two hours, every day. On the other hand, this is infrequent compared to the constant connection of a Bluetooth device. Notifications can be turned off under settings.
- My Skin Track UV connects physically to the user's clothing with a metal clip. While this may not be a pervasive problem, the clip is loose on some clothing, leading it to possibly slip off during use if the user does not attach it with discretion.
- With both My UV Skin Track and My UV Patch, there is suggestive selling within the app considering there are only La Roche Posay products offered as options. The products also do not change: they aggregate based on self-reported skin care needs from the user when signing up for service.
- The NFC scanning can be cumbersome if the phone is housed in a case. Moreover, the scans often failed using an Android Google Nexus 6p.

**Comparison to science:** sun exposure measured versus actual scientific weather forecast during use.

Positive outcomes:

- Several data points in the My Skin Track UV app are pulled based on the user's exact location, creating a hyperlocal weather experience. Many weather apps are based more broadly on the city in which a user is located, so the data is less customized for weather.
- Potential negative outcomes:
- La Roche Posay has hyperlocal connectivity with respect to weather. By utilizing the Weather Channel plugin for the North American market, users can notice a difference in the weather forecast in general versus the app's forecast.

**User Education:** measured data presented to users during use.

Positive outcomes:

- My Skin Track UV tailors its algorithm to a user's specific skin tone.
- Both apps feature maximum sun stock percentages along with UV levels (index) updated throughout the day and based on the physical location of the user.
- Both apps feature pollen and smog levels, including general pollution levels.
- Potential negative outcomes:
- The users skin tone is a self-reported item that affects the algorithm tasked with monitoring sun exposure.
- My Skin Track UV requires updated NFC connections in order to update and provide a more detailed analysis of sun exposure. This is potentially inconvenient.
- The hardware fails to register UV exposure when sunlight is indirect.

## Discussion

Skin cancer is among the most common form of cancers in the United States. To that end, My Skin Track UV and My UV Skin Patch measures UVA and UVB exposure, noting the users' sun-stock while also tracking pollen, pollution, temperature, and humidity. This paper has discussed application topics, such as the background of LED and NFC technology, and it has reviewed similar skin care applications as well as health education, uses and gratifications.

## **Comparisons to Previous Research**

While there have been no academic or clinical trials of this product, consumer tests from individuals and the general media are available online. There are also general product reviews from consumers widely available online. The reviews were mixed, with interpretation possibly showing that there was no outstanding public opinion. Many reviews reiterated that the information provided by the hardware and companion app were readily available online or on the user's smartphone. However, maximum sun stock is one area where the hardware and app provide new data.

## **Limitations of the Study**

There were no focus groups or other large-scale tests of the product. The study was limited to discovery research based on the criteria outlined in the methodology and results sections of this paper. All tasks listed in My Skin Track UV were not tested individually. Moreover, due to a lack of patches in stock, this study could not test My Patch UV individually. After signing up, the app required a software update before the app would function.

## **Suggestions for Future Research**

There should be a larger scale study with pre- and post-testing of knowledge about users' outdoor sun exposure. Moreover, an analysis of users engaging in the trial could have a pre- and post-test covering exposure to gauge whether the exposure to UVA and UVB light diminishes as a result of using the hardware and software.

## **Conclusion**

Light emitting diode technology allows users to monitor indoor and outdoor environments while engaged in various tasks requiring exposure to UVA and UVB light or other environmental aggressors and factors. My UV Patch and My Skin Track UV provide the benefit of LED technology for monitoring many external conditions that directly relate to skin and respiratory health. The hardware and software do have several drawbacks but they do not outweigh the benefits dependent on situational analysis and user needs.

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