Wearable Epilepsy Seizure Monitor User Interface Evaluation
An Evaluation of the Empatica 'Embrace' Interface

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Introduction

Patient monitoring systems capable of accurate recording in the real world, during the activities of everyday living, create opportunities to make real-time assessments of patient well-being, respond to potentially critical events and support clinical decision making [1].

Epilepsy is a neurological condition that affects 50 million people worldwide [2]. While antiepileptic drugs can control the seizures of many individuals, more than 30% of people with epilepsy have drug-resistant seizures [3]. Epileptic seizure types vary considerably between convulsive and non-convulsive seizures including 'tonic' and 'clonic' muscular contractions and relaxations, 'atonic' losses of muscle strength and 'absence' episodes where individuals can lapse awareness and appear detached. For epileptic individuals, the hailing of timely care with automated messages at seizure onset has the potential to reduce injuries and, potentially, save lives.

Epilepsy seizure detection and wearable patient monitoring are active areas of research but there is currently a lack of work evaluating seizure monitoring technologies currently available to individuals and researchers [4]. This work makes a novel contribution to this area.

Achieving useful and unambiguous information delivery via the small screens and minimal interfaces of wearable devices poses design challenges. At the same time, it is important that devices are aesthetically acceptable and, particularly in the case of health-condition monitoring, it is important that devices are discreet and do not stigmatize wearers.

Minimal interface indicators can quickly become familiar to individuals wearing devices every day. But, in critical healthcare applications there are other stakeholder users or observers beyond wearer users, for example, caregivers, family members or colleagues.

Method and Materials

Fourteen Computer Science students and researchers experienced in heuristic evaluation were recruited according to Keele University Faculty of Natural Sciences Research Ethics Committee approval (NS-200058) to evaluate the LED interface of the Empatica Embrace wearable seizure monitor.

Participants comprised two academic staff members, three PhD researchers, and four masters and five undergraduate Computer Science students. Participants were shown each of the eight animated interface indications shown in Figure 1 and were asked to guess on a scale of 5-1 (5 = definitely is and 1 = definitely isn't) what each of eight LED interface patterns signified: Battery Low, Disconnected, General Connection Problem, Memory Full, Rebooted, Reconnected, Time and Unusual Event Detected.

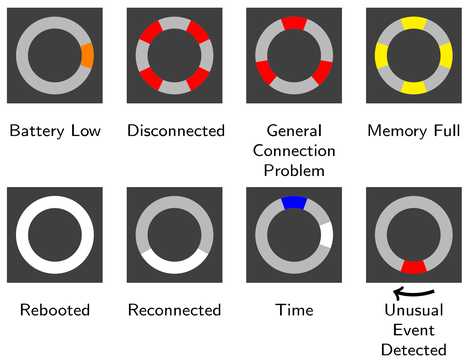

Figure 1: Embrace LED Interface Examples.

On completion, participants were shown the correct answers for each condition and asked to complete a heuristic evaluation based on Neilsen's 10 Usability Heuristics for User Interface Design [5]: 1) visibility of system status, 2) match between system and the real world, 3) user control and freedom, 4) consistency and standards, 5) error prevention, 6) recognition rather than recall, 7) flexibility and efficiency of use, 8) aesthetic and minimalist design, 9) help users recognize, diagnose, and recover from error, and 10) help and documentation.

Results

Figure 2 presents box plot results for the 5-1 (5 = definitely is and 1 = definitely isn't) LED interface guesses. Ideally, the correct LED patterns (shaded in green) would have averages close to 5 and the incorrect conditions would be close to 1.

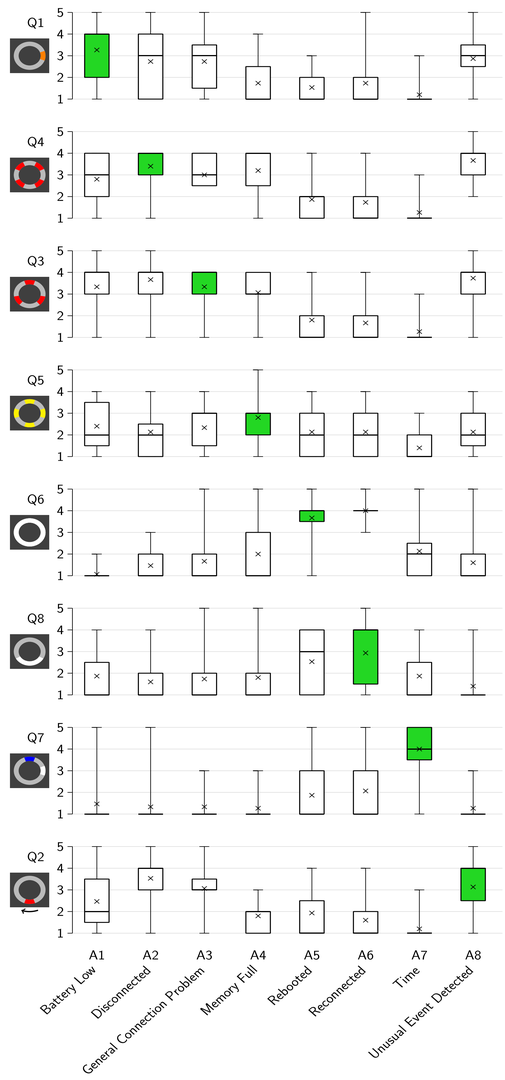

Figure 2. Guessability Box Plots. (5=definitely is, 1=definitely isn't). Correct instances are shaded in green, 'x' marks mean, bar marks median and box and whiskers indicate interquartile range and max/min, respectively.

Conclusions & Further Work

The Time display was the most recognized display. Only one participant was confident the Time display was not Time and, at most, one participant guessed that Battery Low, Disconnected and General Connection Problem, were Time indicators. Unfortunately, the spinning red Unusual Event Detected display that can signify a seizure was not guessed well and was confused with Battery Low, Disconnected and General Connection Problem.

Minimal light pattern displays have a pleasing aesthetic but can be confusing to users lacking familiarity with the interface. Ideally, each displayed pattern could be correctly guessed from the set of possible meanings.

Improvements in the design of interface displays for wearable devices and particularly for devices used in critical health monitoring scenarios with wearer users and non-wearer user stakeholders.

References

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