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Augmented packaging for improved medicine compliance

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Augmented Packaging for Improved Medicine Compliance

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Abstract

In studies that have explored the problem of medical non-compliance, i.e. where patients do not adhere to a prescribed regime is a significant and complex problem (Eraker et al, 1984), it is estimated that non-compliance with short-term medication regimes can be as high as 92% with an average of 50% for some chronic diseases (Bergman and Werner, 1963). In their review paper Eraker et al list a series of possible reasons for non-compliance such as the patients world-view, patient knowledge and experience, social interactions, social and demographic factors along with issues surrounding the training of healthcare professionals.

Roter et al (1998) undertook a meta-analysis of compliance research across a range of health issues and intervention types. The study showed again, that the issue of compliance is complex and that no single intervention strategy works across the board and that success can depend on the condition being treated and the relationship between the doctor and the patient.

With the advent of the World Wide Web, interactive technologies and the advent and use of smartphones, there exists the potential to examine the use of this technology as an aid to medical compliance, in particular the improvement of medication regimes. Current digital technology to aid compliance is largely in the form of downloadable 'Apps' that allow a user to register and monitor their pill usage.

This paper outlines work on a feasibility study looking at the use of Augmented Reality (AR) to provide support and supplementary information to patients undergoing various medication regimes. Using interviews and observation techniques the study contrasts and compares the patient experience and compliance data between using the AR and undertaking their 'standard' medication regime. The paper discusses the feasibility of using image recognition AR and proposes routes forward for this technology in aiding medical compliance.

Keywords: Mobile Augmented Reality, participatory design, design, medicine compliance

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Introduction

According to a 2014 OFCOM independent report on the uptake of telecommunications devices the ownership of smart phones and computer tablets continues to grow in the UK, with six out of ten people now claiming to own a smart phone and 44% of households owning a tablet computer, almost double the figure from the previous year (OFCOM 2014). According to the OFCOM report 14% of people aged 65-74 now own a smart phone and one in five aged 65+ owns a computer tablet. This increase has facilitated a rise in mobile web access and the engagement in social media, which retailers and brand owners have been quick to capitalise on, increasingly looking for new, 'interactive' ways with which to engage customers. Initially the integration of the digital has been achieved by simple strategies such as packaging having links to websites or Facebook pages. These links typically provide more information about a product, such as nutritional information and dietary advice or value added content like recipes, discounted offers, competitions, games and digital media. The links also connect the purchaser to likeminded consumers and networks where related social-cultural or aspirational content and ideas can be shared.

As well as the potential of connecting to consumer communities, retailers have begun to take advantage of improvements in computing power and hardware and software capabilities. For example, the embedding of microchips in packaging to track freshness and provenance (Trebar, 2014) and the use of smart phones and tablets to offer more advanced technological interaction with products and their packaging.

Examples of this type of digital technology, used to aid and support medical compliance, can be seen through the development of smartphone 'Apps' such as 'Medi-Track Lite', 'Pill Monitor' and 'DoseBox'. These smartphone 'Apps' vary in complexity and visual design. Generally the 'Apps' at a basic level provide users with alert reminders to take specific medication, whilst the more sophisticated 'Apps' may provide pictures of the required medication to aid identification, provide supporting information on the medication and e-mail the patient's Doctor.

Augmented Reality (AR)

AR is beginning to be used within the context of domestic packaging as a means of connecting to the potential of the digital to enhance both experience and information. Although digital AR technologies have been around since the 1960s continuing technical developments in the last 20 years combined with a recent increase in the awareness of AR in the public domain means that we are only now beginning to see the more commonplace use of AR (Bimber, & Raskar, 2005). In simple terms AR is the overlaying or mapping of digital content into a real environment or onto a physical object. This is typically achieved using the built in camera and digital screen of a smart phone or tablet together with propriety software to combine the video image of a real space or object with additional digital information (see Fig.1).

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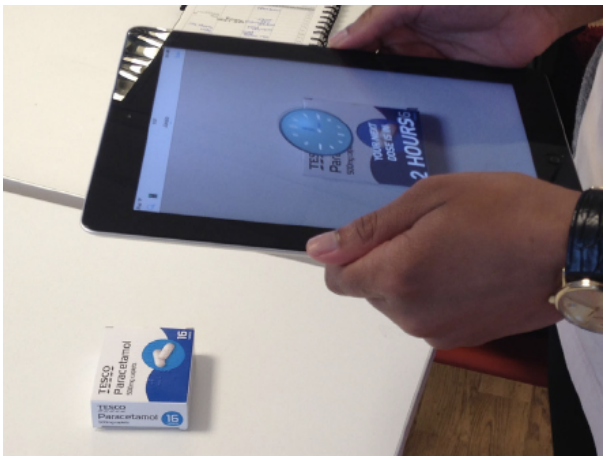

Figure 1: AR content shown on a tablet computer (image Laura Drew 2015)

Importantly AR technologies are capable of recognising and placing digital content in a specific place within a physical environment or in a predefined position in relationship to a physical object. This makes it possible to build a logical connection between the virtual digital material and context in which it is placed. From the user's perspective there are two main ways in which AR can be viewed. These are either through the screen of a hand-held device, such as a mobile phone or tablet computer or through the use of a head mounted display. Using either technique AR provides the user with an enhanced view of a physical environment or object with computer generated graphics or imagery, animation or audio. But unlike the concept of Virtual Reality (VR) where the user is 'immersed' in a digital environment, AR allows the user to retain a connection with their real-world location and experience, allowing the augmented experience the potential to connect to lifestyles and daily routines (Fig 2.).

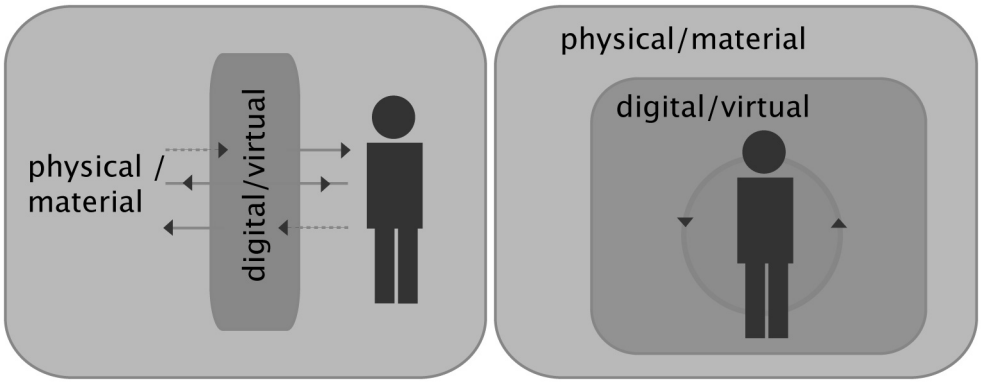

Figure 2: A comparison between Augmented Reality (AR), (left) and Virtual Reality (VR), (right). (Diagram concepts by Mark Billinghurst from The Human Interface Technology Laboratory, New Zealand).

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Traditionally, AR is triggered when a digital device recognises a printed marker in the environment. The most common form of marker is the 'QR' or Quick Response code, which can be seen on various pieces of packaging and printed materials. QR codes are small 2D black and white coded images (a form of bar code), which usually connects to a website (via an embedded hyperlink) when a user scans the code with a smart phone or tablet device. The use of QR codes has become widespread on Fast-Moving-Consumer-Goods (FMCG) packaging but has limited application on Over-The-Counter (OTC) medicines and is largely non-existent on prescription medical packaging.

Despite the prevalence of QR codes on FMCG packs, initial work by the authors (part of a separate study) has shown their use by consumers to be extremely limited to almost non-existent. Where users did engage with packaging related digital content, this was often through the typing of the brand web address rather than scanning the QR code.

However, with advancements in AR and mobile technologies it is now possible to trigger the placement of digital content by recognising specific objects such as the shape of a piece of packaging, or particular illustrations or graphics printed on a product. These enabling technologies mean that the AR experience of digital content can be more integrated as a user interacts with packaging. This immediacy along with development of more tailored and engaging digital content has the potential for improving a user's interaction with prescribed medication compliance and engagement with their medical conditions.

Designing for AR medicine packaging

As we have discussed AR technologies allow for the user's current situation or environment to be overlaid with the addition of supplementary information and graphically designed digital content. This research examines how the capabilities of AR can be applied in the context of medicine packaging in a way that might lead to the better use of prescribed pharmaceuticals and increased awareness and understanding of how and when medication should be taken. An initial survey of current practices has shown that much of the existing AR connectivity is based on the use of QR codes found on packaging that directs the user to an external company website.

In the following design tests experiments were undertaken to see if AR might be used to A: more actively promote user engagement and interaction using a number of digital media forms and B: examine the impact of different interface designs and architectures to present information and user profile data and schedules, specifically reminders of when to take medication or to specify appropriate dosages etc.

A variety of AR prototype designs have been developed to enable user-testing activities in this study and existing applications which attempt to offer these types of services not using the concept of AR are commented on in the following sections.

Research Methods

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For this feasibility study we have focused on the use of hand-held mobile devices. In this initial study four participants were selected with varying degrees of wellbeing requiring prescription or OTC medicine use and compliance. Users were recruited through existing research networks within the ADRC at Sheffield Hallam University (SHU). Ethics approval was obtained through SHU ethics committee and all data was anonymised and stored in accordance with SHU data protection guidelines.

Several meetings were held with each participant to discuss their current medical packaging use, issues and compliance using a semi-structured interview and questionnaire. The participants, three females and one male, were aged between 22 to 72 years and had a range of conditions from Glaucoma and Rheumatoid Arthritis, Crohn's Disease, anxiety and high blood pressure. At the meetings participants were asked questions around the medication they took, their general routine, their interactions with family and healthcare professionals and the understanding of their condition. The participants were also asked for their views and preferences for visual images and graphics to inform the development of an AR interface design.

From these semi-structured interviews a series of concept maps were produced for each participant outlining their needs/wants and current usage of their medication (Fig 3.).

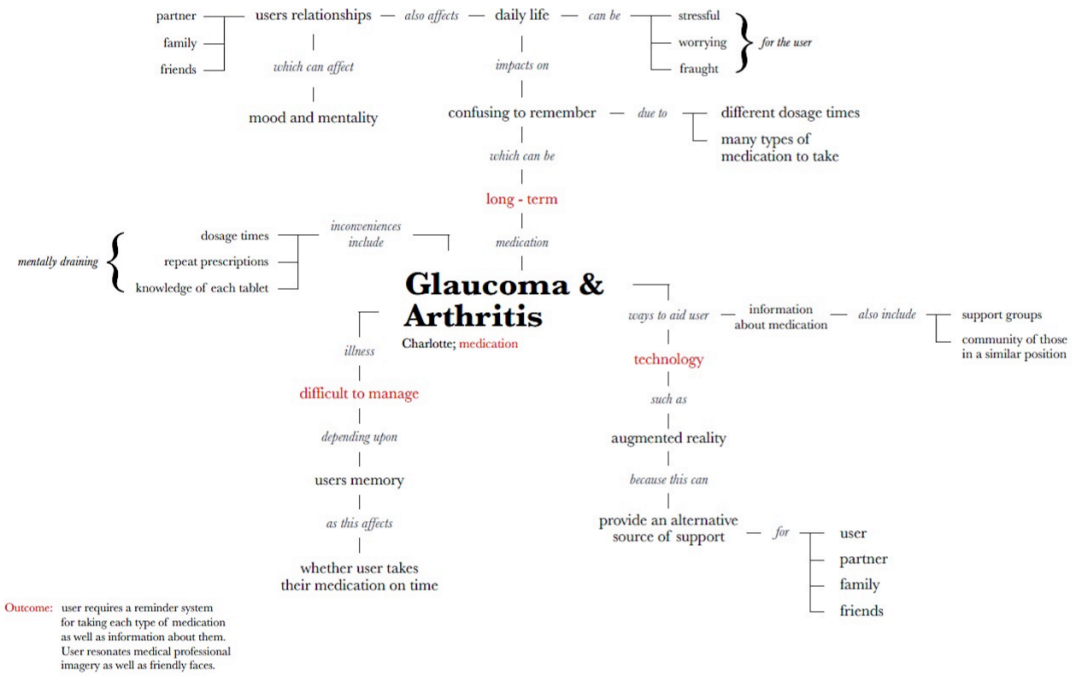

Figure 3: Concept map following interviews of a participant

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These concept maps produced four distinct outcomes for the users;

- Participant A needs a gentle reminder to take tablets on a regular basis. User resonates mostly with friendly images of herself, partner or her/friends and family.
- Participant B needs a friendly interface design incorporating information about supplementary medication, where to buy it and contacts for friendly support groups.
- Participant C requires a reminder system for taking each type of medication as well as information about them. User resonates with medical professional imagery as well as friendly faces.
- Participant D wants a clear reminder system with structured alerts for taking tablets and information about which one needs to be taken with food. User resonates best with medical professionals.

Typical quotes from the participants were:

> "I do forget. Particularly at night. I forget how many I've taken. It would be nice to have something to remind me and engage me and also help my partner." - Participant A
>
> "I do take my medication regularly. I don't understand it all though and I take all these supplements but I like to read all about it and read about the benefits in magazines etc" - Participant B
>
> "I just forget and can't be bothered. I've never really had my condition explained to me really, or what happens if I don't take them." - Participant C

All participants had access to smartphones, however the older participant (Participant B) was less comfortable using the technology. None of the participants had previously used smartphone technology such as 'Med-track' or 'DoseBox'.

Outcomes

Following the production of the concept maps an iterative process of AR interface design was undertaken with each user to ascertain a level of interactivity and usefulness that was appropriate for that particular user. Initial stages looked at differing layouts and interactivity options such as calendars, interface design, animations and other elements of digital content.

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The initial concepts had a similar look and feel to existing 'Apps' and performed in a similar fashion. The main difference being that the information provision and ability to interact with information was triggered by the pack itself. Whilst of interest this approach moved away from the truly interactive approach of AR, whereby there was interaction with the pack and the information.

In a series of secondary meetings participants were questioned again about the use of the smartphone 'Apps' and the look and feel that the AR interfaces might have when working with the physical packaging in view.

From this round of secondary interviews a series of interfaces were developed. An example for participant C is shown in Fig 4.

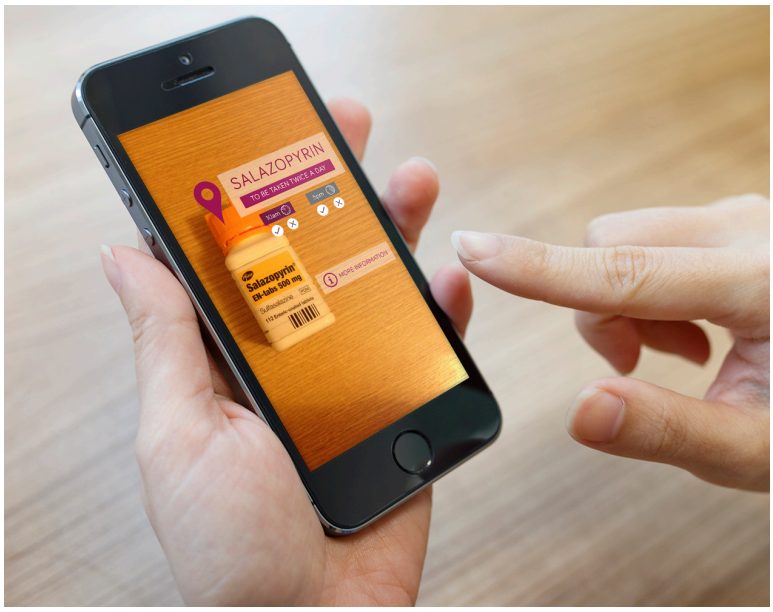

Figure 4: AR interaction with medication pack

Various themes were developed that were specific to each participant but which had similar thematic elements such as the iconography identifying the item in question (as shown above in Fig 4.) All the participants were asked to test the interfaces against their current usage, work for which is still ongoing. However initial results show significant scope for behavioural change when these AR mobile technologies are combined with other elements of a user's digital lifestyle. For example minor changes to one of the AR links gave the participant digital rewards for using and engaging with the interface, something that they had enjoyed and experienced previously with a weight loss 'App'.

Conclusion

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As Steven Benford describes, AR technologies can be used to label physical objects with instructions, give guidance and directions and even populate the physical with virtual characters and objects (Benford, 2002). This work has begun to show that AR technologies can be successfully used on medicine packaging and may possibly aid with improved compliance.

The initial small-scale study shows that in order for this technology to work the AR content and experience will need to be personalised to the individuals needs. However, how and why people take medication is a complex issue and what role AR might take in motivating people to take their medication needs to be looked at in more detail. There are of course other issues raised by the work. For example how the user will identify the medication pack has some AR functionality when the technology no longer requires the visual cue of a QR code, and other issues around technical understanding. In this study Participant B was an older woman with high blood pressure and arthritis who had a low level of technical competency with her smartphone. She found the AR 'fascinating' and fun and it was presented in a way that engaged her (this user liked to read magazines so the interface played on the theme of newspapers), however how this would work for other users of low competency remains unclear. Finally the source of information that is linked to the packaging has to be reliable and robust. This may be true for all applications of this type (including 'Apps') and so care may need to be taken.

Clearly the concept of AR has significant potential to aid understanding and engagement with packaging and in this instance medication. However, integrating it into users regimes and current healthcare provision systems is a complex issue that requires significant understanding before the augmentation really will become a reality.

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