The Augmented Shopping Trolley: An Ambient Display To Provide Shoppers with Non-Obvious Product Information

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ABSTRACT
The Augmented Shopping Trolley consists of an ambient handlebar display connected to a scanner. When a shopper scans an item the handlebar lights up to provide them with information about the product, such as its nutritional, ethical or environmental attributes, that are not obvious from its packaging or label. The system is designed to seamlessly integrate with a shopping experience: it uses familiar supermarket technologies; it keeps both of a shopper's hands free; and the simple ambient display facilitates the 'fast and frugal' decision-making typically observed in a supermarket. Our initial lab-based study shows that the display can be understood at a glance and used to select items based on a product's *nominal* properties (for example, it is organic), *ordinal* properties (for example, it has low, medium or high food miles), as well as a combination of the two at the same time. Where as usability was the focus of our initial design, ethical issues have come to the fore as we develop the system for use in supermarkets and we discuss how these are influencing our design.

Author Keywords
Persuasive technologies, ambient display, shopping, product information, ethics.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
In a supermarket, shoppers tend to make snap judgments based on just a few salient cues (low price, recognized brand and attractive packaging) and they rarely take time to read product information labels [7]. However, recent consumer surveys indicate that shoppers want more information about the global consequences of their consumer decisions [2]. Our goal is to provide 'non-obvious' nutritional, ethical and environmental product information, that is, information that is not immediately obvious from an item's packaging or label, in a form that is as salient as the features that typically inform consumers' decision making. The Augmented Shopping Trolley (Figure 1) is designed so that it fits as seamlessly as possible into a supermarket shopping experience. We use familiar supermarket technologies: augmenting a standard shopping trolley by attaching a scanner and embedding an ambient display in the handlebar. This gives our system two advantages over using mobile devices to provide product information. First, the trolley scanning technology is faster [4] and second, because the ambient display is built into the trolley handlebar a customer's shopping experience is not disrupted by having to repeatedly access and store a mobile display. Underhill [10, see chapter 4] emphasizes the importance of having both hands free during shopping.

Figure 1. The Augmented Shopping Trolley display consists of 16 LEDs embedded in the handlebar, each of which can be set to green, red or orange

Our approach to designing an effective ambient display, first outlined in [9], is motivated by studies of ecological rationality which investigate how people make reasonable decisions given the constraints of limited time, information and computational resources that characterize most real world situations [6, 8]. This research indicates that most natural decision making is made on the basis of 'fast and frugal' heuristics – short-cut strategies where people ignore most of the available data and instead focus on the most useful information and process it quickly. Often people make a decision based on a single reason as this strategy is quick and simple and avoids having to weigh up trade-offs between multiple and potentially conflicting options. This approach is not rational in certain environments, namely, those where available pieces of information are approximately equally useful. However, in a shopping environment, the distribution of information usefulness is highly skewed, that is, the most useful piece of information is a lot more important than the second most useful, which in turn is considerably more important than the third, etc. Our handlebar ambient display consists of just sixteen LEDs. When a shopper scans a product, a few pieces of non-obvious information, such as whether it contains nuts, is fair trade or has low food miles, are displayed as a salient pattern on the display.

Given that information salience influences a person's behaviour unconsciously [1], rather than through rational reflection, this raises ethical concerns about the Augmented Shopping Trolley, chief of which is that this system could potentially manipulate people into behaving in ways that they would not otherwise do, and furthermore, that they might not be aware that they had been manipulated. This concern, and also issues to do with privacy and clarifying how our system benefits shoppers, form the ethical considerations that are influencing how we deploy the Augmented Shopping Trolley in a supermarket.

The paper is structured as follows: first, we describe the display hardware and how it conveys product information; second, we describe a lab-based evaluation of the system that demonstrates the efficacy of the ambient handlebar display for conveying non-obvious product information; and third, we describe the ethical issues that are informing the development of the system for use in supermarkets.

AMBIENT HANDLEBAR DISPLAY DESIGN

The handlebar display was designed to provide shoppers with salient and easy to read information about a scanned product's nominal properties (for example, whether it is organic or contains nuts), its ordinal properties (for example, if it has low, medium or high food miles), as well as a combination of the two at the same time. We constructed the display by attaching 16 bicolour LED units to a piece of wood inside a transparent plastic tube (Figure 1). This replaced the plastic handlebar in a standard shopping trolley. The LEDs are controlled using 2 TLC5940 chips (Texas Instruments) that are driven by an Arduino microcontroller. In our lab-based study this is attached via a USB cable to a laptop running a Processing application. Each LED unit can be set to red, green or orange (when both the green and red LEDs are on). Each time a product is scanned, the display changes in the following way. First, it goes from an all green background (idle state) to a half second sweeping movement of orange that indicates scanning is in progress. There is then a beep, as typically heard at a checkout counter, to signal that scanning is completed and the display then changes to a new state that provides relevant information about the product. If the display is configured to show a nominal property of the product, then it flashes green if the property is present and shows the idle state if it is not. If the display is providing ordinal information about the product, the display employs a bar graph metaphor, with the number of red pixels indicating the degree to which an item has a property. Specifically, if an item has a low degree of a property then pixels 1-3 turn red and 4-16 turn green; if medium then pixels 1-8 turn red and pixels 9-16 turn green; and pixels 1–13 turn red and 14-16 turn green if the item has a high degree of a particular property. Finally, both these representations can be combined to show the value of a nominal and an ordinal property at the same time. In our study, after a participant selected or discarded an item, the display changed back to the all green idle state.

LAB-BASED SYSTEM EVALUATION

5 adults (1 female, 4 male, aged between 20 and 40) took part in a lab-based evaluation of the Augmented Shopping Trolley. Each participant completed 12 shopping scenarios where they were asked to pick up and scan 5 items of a particular product type and only select those items that met specified criteria. A scanner was attached to the shopping trolley (Figure 1) but was non-functional and the handlebar display was changed using a Wizard of Oz methodology.

On the basis of the changes in the patterns on the handlebar display, participants had to decide whether to select the item and place it in their trolley or discard it and place it on an adjacent table. Since this was an exploratory study, we were intentionally vague about the operation of the ambient display as we wanted to see whether participants could understand it intuitively. We only told participants that the display patterns would change depending on whether a product had a specific property (yes/no), the degree to which a product had some property (high/medium/low) or a combination of the two. Participants were allowed to scan the items as many times as they wanted and in any order, before they made their decision about whether to select a particular item. We used 4 product types: milk; breakfast cereal; wine; and juice. Each shopping scenario used one of the product types and participants were asked to select from 5 different items. For example, select those bottles of wines that meet the specified criterion (fair trade) and put them in the trolley, and place the others on the discarded items table. Each of the items was a real product but we masked any product information on the packaging and told participants to only use the handlebar display to decide whether they should select an item or not. The experimenter playing the Wizard of Oz role sat at a table on which the 20 shopping items were grouped by product type. Each item was individually numbered so that the experimenter could change the display appropriately when the participants scanned a particular item.

In the first 4 shopping scenarios the handlebar display indicated whether a scanned item had a particular nominal property or not: whether a milk product was organic; whether a breakfast cereal contained nuts; whether a bottle of wine was fair trade; and whether a carton of juice contained added sugar. In 2 of these scenarios the participants had to *select* items that had a particular property and in the other half they had to *discard* items if they had a particular property. For example, in the first shopping scenario participants had to select a milk product if it was organic and discard it if it was non-organic; in the second shopping scenario participants had to select a breakfast cereal if it did *not* contain nuts and discard it if it did.

In the next stage of the evaluation, the participants completed 4 shopping scenarios where the display indicated whether a product contained a low, medium or high value of a particular ordinal property. The task was to select items that had a specified property to a particular degree. Specifically, participants were asked to select milk with a medium fat content, cereals with a high sugar content, wine with low food miles and juice with a medium water content. In none of these scenarios were participants asked to discard items if they had properties of a particular degree. The final 4 shopping scenarios tested whether participants could understand the display when it simultaneously showed information about both a nominal and an ordinal property of a scanned item. Participants were asked to select milk that was organic and low fat, cereals that contained nuts and had a medium sugar content, juice that had added sugar and high water content and wine that was not fair trade and had medium food miles. Only in the wine scenario did participants have to reject items on the basis of information about a nominal property of the product.

USABILITY RESULTS

4 out of the 5 participants were able to interpret the ambient handlebar display and complete all the tasks without any mistakes. The other participant made one consistent error in 2 of the first shopping scenarios where the task was to discard items if they had a particular nominal property: they selected, rather than discarded, them, but did not repeat this error in the final shopping scenario which also required an item to be discarded if it had a particular nominal property. Several participants reported that they found the tasks where they had to discard items with particular properties more difficult and it did seem to increase the cognitive load in all participants, resulting in a slightly slower response time (approximately 2 seconds, rather than 1 second for the other conditions). This could be due to the colours used in the display: a nominal property is indicated by a green blinking display, a colour that many people associate with positive properties, rather than ones that should be avoided. All participants reported that the display was intuitive to use and were able to quickly read it even though they were not given explicit information on the meaning of the display patterns. Only two participants scanned items more than once and this was exploratory activity at the beginning of the evaluation when they were seeing how the interface worked.

ETHICAL ISSUES AND FURTHER DEVELOPMENT

Whereas usability issues informed our initial design, ethical considerations are shaping the development of the Augmented Shopping Trolley for use in supermarkets. This is because our ambient display not only provides salient product information for shoppers, but also potentially influences what they purchase. The use of persuasive technologies raises ethical concerns for many people. For example, Page and Kray [3] used an online questionnaire to investigate people's views on the ethics of using persuasive technologies to encourage healthy living. 72 participants rated the ethical acceptability of a number of different scenarios which varied in 3 different factors: whether a participant chose to use the technology or an external agency initiated its use; whether there was a clear benefit for the participant or not; and the technology used (text messages to the participant's mobile phone; public announcements in the participant's location; Facebook messages; restrictions on the participant's bank account; and electric shocks). The results indicated that the majority of the participants viewed the use of persuasive technologies in most of the questionnaire scenarios as unethical. When there was no clear benefit to the participant, mobile phone were considered the most ethical persuasive technology. However, approximately the same proportion of participants (40%) considered them very ethical or ethical as the proportion that considered very unethical or unethical when. A large majority of participants found the other technologies very unethical or unethical. In scenarios where the use of a technology would clearly benefit the participant, for example, save their life, then this usage was considered slightly more ethical than the cases where the technology did not benefit the participant. However, it is not clear whether these differences were statistically significant. When people were able to freely choose whether to use a persuasive technology or not, then texts, public announcements and Facebook messages were considered ethical by the majority of respondents, in comparison to the situation where the use of the persuasive technology was initiated by an external entity (for example, the UK's National Health Service). Electric shocks and bank account restrictions were considered very unethical or unethical by the majority of respondents, even when a participant chose to use them.

Page and Kray's findings seem to concur with a central factor identified by applied philosophical analyses of ethical behaviour, for example, the use of persuasion in advertising [5]. Namely, the ethics of an action are determined, to a large degree, by the extent to which that action impacts on an individual's autonomy, that is, their capacity to choose how to act and determine their own life. Page and Kray's research also highlights that privacy and the extent to which a participant benefits are important issues for determining the ethical acceptability of persuasive technologies. All three of these ethical considerations (autonomy, privacy and benefits) are shaping the development of the Augmented Shopping Trolley.

To ensure shopper's autonomy, they will be free to decide whether they use the Augmented Shopping Trolley and also able to choose which particular non-obvious product information they want to be informed about. Given that users can configure the system to provide different product information, privacy is not compromised, even though the handlebar will be visible to other shoppers, as they will not understand what particular LED patterns mean. Some of the product information that will be provided by the Augmented Shopping Trolley can clearly benefit a participant, for example, nutritional data, whereas other information, such as food miles, may not have direct personal benefits. In fact, trying to minimize food miles may lead, literally, to a personal cost. However, we assume that if participants choose to be informed about a particular type of product information then they do so because it is of benefit to them and in keeping with their lifestyle choices. We are currently considering how to use the display to provide aggregate information about the contents of a participant's trolley. The display could indicate how averaged values of all the participant's purchases relate to some norm(s), for example, is the weekly shop below or above the average shopper's food miles. Clearly, there are normalization issues to be resolved to enable such comparisons to be made. One ethical consideration with this type of display is that even if an observer did not know what aspect of product information the aggregate display encoded, under certain conditions it could be evident whether a participant was above or below a norm, thereby compromising a shopper's privacy. For example, if the observer had also used the display themselves and the colour encoding was fixed. One way to ensure privacy is to allow participants to customize aspects of the display, such as the colour encoding used. A second ethical concern with this sort of display is that norms, like salience, typically influence people unconsciously. To ensure that the autonomy of participants is not compromised it seems important to inform them about the methods used in a display and how these typically influence behaviour before they choose to use the Augmented Shopping Trolley

CONCLUSIONS

Our lab-based study shows that participants can rapidly read a shopping trolley handlebar display to determine both nominal and ordinal properties of a scanned product. Our display is intuitive to use and requires no training. Participants find it easier to select items when they have desirable properties than to not select them because they have undesirable properties. The Augmented Shopping Trolley makes non-obvious nutritional, ethical and environmental product information salient to shoppers and facilitates the fast and frugal decision making typically used in a supermarket. Some of the global consequences of selecting particular products can now be made salient to shoppers at the point of decision making, potentially facilitating changes in consumer behaviour. We argue that our system is an ethical persuasive technology as it enhances the ability of shoppers to buy choose products in accordance with their individual values.

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