A Conversational Model for Health Promotion on the World Wide Web

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Abstract. In this paper we describe a new approach to computer-based health promotion, based on a conversational model. We base our model on a collection of human-human email dialogues concerning healthy nutrition. Our system uses a database of tips and small pieces of advice, organised so that support for the advice, and arguments against the advice may be explored. The technical framework and initial evaluation results are described.

1 Introduction

The use of interactive, computer based systems for health education and promotion has a long history [6]. However, the World Wide Web (WWW) presents new possibilities for interactive health promotion (e.g., [5,7]). Materials can be developed which can be accessed by anyone with a WWW connection, and perhaps as importantly, tools and ideas easily shared among health promotion researchers.

There are now numerous WWW sites dedicated to health promotion[1]. Most combine the presentation of health information with some interactive component, and often online support groups. In this paper we focus on interactive tools for the promotion of healthy nutrition.

In nutrition education, there are two main interactive tools that are used. The first is the quiz. While good quizzes can be useful, they often presume some initial motivation of the user to study and acquire some basic nutrition facts first. The second type of interactive tool used is a nutrition assessment. Users typically enter information about their current diet (selecting from meal options), and personal facts such as weight, sex, and activity level. They then receive an assessment of the nutrients in their meal selections. While this can be very useful for relatively sophisticated users, it is difficult to develop systems that provide a useful and meaningful assessment for relatively naive users who may not understand the nutrition concepts involved.

This paper presents an alternative approach to interactive health promotion, based on a dialogue with the user centered on practical tips. In our system the users make a number of simple meal choices, then receive tips for improving the

[1] See http://www.arbor.com for a reviewed selection.

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meal. They can respond to each tip in various ways, asking why it is recommended, stating objections to it, or rejecting it outright. The system is based on a simple conversational model, emulating aspects of the conversation between human dieticians and advisees. While we focus on nutrition education, the framework is designed to be easily adapted to other areas of health promotion.

In the following sections we present the background research, in health promotion, and conversational modelling. We describe our initial study of human health promotion dialogues, and show how this influenced our system design. The system itself is described in detail and a preliminary evaluation described.

2 Background

2.1 Promoting Healthy Nutrition

Health promotion can be described as "the process of enabling people to increase control over, and to improve, their health" [13]. It involves both providing information, and advocating healthier behaviours. The promotion of healthy nutrition is currently seen as particularly important – healthy nutrition can have a crucial role in decreasing the incidence of illnesses such as cardiovascular disease or cancer. Education and persuasion is only part of what is required to change people's behaviour, to be considered in combination with attempts to remove external barriers to healthy nutrition (e.g., cost and availability). Nevertheless, it is an essential part of health promotion, and one that has proved very difficult – getting people to change established behaviours is hard. Mere information provision is inadequate - interventions should take into account behavioural theories and goals, and incorporate some degree of personalisation [11].

While the best approach to the promotion of healthy nutrition may involve personal contact, there is an interest in low-cost intervention methods. Campbell *et al.* [1] demonstrated the impact that personalised leaflets could have. Leaflets, tailored according to the Stages of Change model [9], resulted in a significant (4%) reduction in fat intake. While there is interest in more interactive computer-based approaches, there are few trials to date which demonstrate their potential. One exception is Winett *et al.* [14] who describe a trial of a computer-based intervention to help supermarket shoppers alter food purchases – participants using the system decreased high fat purchases, and increased high fibre ones.

More recently, many nutrition information sites have been developed for the WWW. While in most cases, their effectiveness in health promotion has not been formally assessed, many have thousands of visitors. Though many of these may already have a good diet, the sites nonetheless provide an opportunity for new novel interventions to re-inforce suggestions for dietary change.

In our work we aim to contribute to the collection of techniques available for the development of such interactive health promotion sites.

2.2 Modelling Persuasive Conversation

We are interested in how theories of human persuasive communication and dialogue can be applied to computer-based health promotion.

We combine a model of argument structure, with a conversational framework. We use Toulmin's model of argument structure [12]. He suggested that effective human arguments share common elements:

- A claim (e.g., You should eat more fruit and vegetables.).
- Support for the claim (e.g., People who eat more fruit have less disease).
- Qualifiers, anticipating possible counter arguments or exceptions (e.g., *Most people* should..).
- Warrant, linking claim and support (often unstated).
- Concession, acknowledging part of the opposing argument. (e.g., Although you may not like all types of vegetable..).

These elements provide a useful way of organising the elements of an argument. However, the model does not provide us with guidance as to how the *conversation* with the user should be managed - how much of an argument should be presented at once, and how can we manage the interaction.

Our conversational model is informed by two complementary models of natural language discourse. The first is the dialogue game [2]. Dialogue is modelled as a sequence of moves. You can be in various game states, and from each possible state different moves are allowed (e.g., ask a question). Dialogue games can be conveniently represented as transition networks (see Fig. 4) and are widely used as a way of representing options in a dialogue, in natural language processing and HCI (e.g., [10]).

The second model emphasises the hierarchical structure of discourse. Grosz and Sidner's model [4] links the hierarchical structure of discourse to the objects in focus. In this type of model, a stack can be used to store discourse elements which should be returned to when the current element is complete. For example, given an interruption from the user we can place the previous (uncompleted) discourse goal on a stack to be returned to when the interruption is dealt with.

Our model, described in detail in Section 4, uses a representation of the underlying arguments influenced by Toulmin's model. There is an (implicit) dialogue game representing options at each state in the interaction, and a stack based model of dialogue contexts.

3 Knowledge Elicitation

Our goal was to emulate aspects of the conversation between a human advisor and advisee. As we wanted the human participants responses to be fully thought out, with no time pressure, we engaged users in email conversations concerning healthy nutrition. In the first experiment the researcher role-played different advisees, engaging in a dialogue concerning healthy nutrition with five nutritionists. In the second the researcher role-played the advisor.

We looked at the overall structure of the (email) conversation (e.g., how it was opened), the way tips and suggestions were presented and followed through, and also noted the specific tips offered. In the first experiment, all nutritionists asked, early on, for some information about current diet (e.g., "What are you

R: Have you thought of adding some fruit to your breakfast?
U: I know I should, but I'm often in a hurry to get to work that all I can do is eat what I have in my desk drawer. I buy fruit, but it just sits there until it goes bad.
R: You could have a glass of juice. It's just as quick. Or add some tinned fruit to your saltines.

Fig. 1. User objections and concerns expressed (R = researcher, U = user).

having for dinner tonight?"). They then moved on to making some suggestions, while asking for more details about the diet. Some also asked early on about current attitudes to dietary change (e.g., "Are you contemplating increasing your vegetable intake in the near future?"). These followed, sometimes explicitly, the Stages of Change model [9].

Most of the main body of the dialogue was centered on a number of tips or suggestions – one suggestion might lead to several (email) messages, as the advisor followed up on any responses of the user. While advisors never argued with the advisee, some of these follow-up messages were concerned with dealing with objections and concerns about the tips, and so can be viewed as presenting a more complete 'argument' for the suggestion in question. Figure 1 gives one example sequence from a second email experiment, showing an advisee posing an objection that needed following up.

To guide the development of our system we also looked at numerous leaflets concerned with the promotion of healthy nutrition. Most gave simple nutrition information, supplemented by practical tips and recipe/meal suggestion. The practical tips listed in these leaflets formed the core of the 'tip' knowledge base in our implementation. We have so far included 140 tips, and linked these to particular meal choices. While still restricted, this goes beyond what is likely to be found in an individual leaflet, and allows for both better linking of tip to user, and better follow-up on tips given user responses.

4 System Description

Our system uses a conversational model, and an underlying database of tips. Initially the users are asked for some information about their current diet (selecting meal components from a menu). They then receive tips about how to improve the meal they have chosen. They can respond in various ways to the tips, allowing a moderately complex 'conversation' to develop. The basic structure of the interaction, asking about meal choices, followed by tips and follow-up information, is based on that observed in the dialogues with our human nutritionists.

4.1 Tip Knowledge Base

The tips (pieces of advice and supporting facts) are organised in a uniform structure. Tips are viewed as 'arguments' that have a main claim, some support,

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tipclaim(t002, 'Grill or bake meat, rather than frying.').
tipsupport(t002, t008, 'The fat drips off into the grill pan.').
tipsupport(t002, t15, '').
tipobjection(t002, o03).
tipobjection(t002, o09).
..
tipclaim(t008, 'You should reduce the amount of fat in your
diet.').
..
obclaim(o03, 'I definitely won't stop frying things').
obresponse(o03, t024).
..
tipclaim(t024, 'Try stir frying using a little oil.').
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Fig. 2. Example tips and objections.

possibly a warrant, but which anticipate a number of objections (allowing concessions). Each piece of support for a tip is represented as another tip (and has its own support etc). Warrants are represented simply as optional texts linking the tip with the support. Objections are represented separately; each objection may have a number of possible responses each of which is a tip. We do not represent or reason about what the tips mean, just how they relate together. Figure 2 gives a number of (simplified) tips and objections, showing the different components. The third argument in the 'tipsupport' term is the optional warrant.

We specify when a tip is relevant. The simplest case is to make it relevant to a given selected meal component, for example:

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relevant(t002, sausages).
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This tip will be considered if the user has selected this item for their meal. We can also define more complex rules, for example:

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relevantifno(t007, vegetable) :- mealtype(dinner).
```

This tip is relevant if the user has not selected anything from the vegetable category, and the current meal being considered is dinner.

4.2 Conversational Model

These tips provide the basic knowledge base behind our conversation system. Once the user has selected meal components, a relevant tip is presented. The user has then the option of responding in a number of ways (by clicking on an appropriate button). They can ask Why? the suggestion or claim is valid, select But.. and pose an objection, reject a tip by selecting No Way!, or select OK! to accept a tip and move on (see Fig. 3). The Why? button is omitted if there is no support stored for the tip.

If they select Why? the supporting information is presented. As this is represented as another 'tip' all the same options apply. If they select But.. the

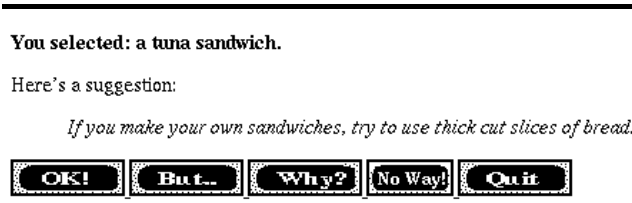

Fig. 3. Example screen.

possible objections are listed, and also a text box presented, allowing the user to enter new unlisted objections[2]. Once an objection is selected, a response to that objection is given. This is again a tip, so the above options again apply.

The options in the conversation can be represented as a transition network (dialogue game). Currently the systems responses always involve presenting a tip (possibly as support to another tip, or response to an objection), or presenting a menu of possible objections. We therefore represent the user's options as arcs, with the basic system 'states' being either T (tip) or O (objection) (Fig. 4).

4.3 Managing Responses

The above model illustrates the basic structure of the conversation, but does not show how responses are selected, or how the 'focus' of the dialogue is managed.

If the user selects But.. or Why?, the current tip is placed on a stack of tip contexts, to be returned to once the subdialogue concerning the objection or request for support is completed. The dialogue is therefore hierarchical in structure, and returns to 'higher level' contexts are made explicit. When the user has accepted a supporting tip, the system restates it (possibly in a shorter version) and reminds of the current context:

> OK, so remember: 'Eat lots of starchy food'. Let's go back to: *If you make your own sandwiches, try to use thick cut slices of bread.*

These explicit reminders appeared useful in preventing people lose track of the structure of the conversation, and ensured that all 'loose ends' in the conversation were followed up.

As the dialogue progresses, the system keeps track of which tips have been used, and which have been accepted. This is used, in a simple way, in the selection of responses and the presentation of new tips. If a previously used tip is an appropriate response (possibly in a new context), the system will remind the user of the old tip, and if possible present an alternative response as well:

> Here's why: It is recommended that you eat at least 5 portions of fruit and vegetables a day.

[2] These objections are recorded, and used to enhance the system in later versions.

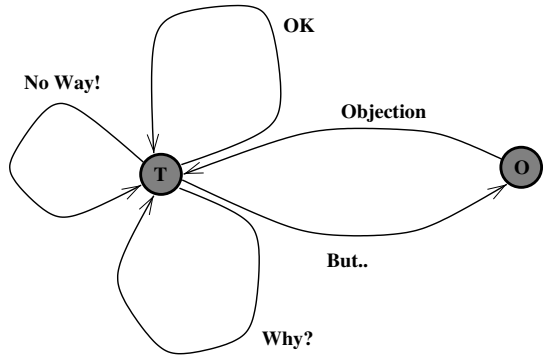

Fig. 4. Dialogue Game

> As we've seen before: Fruit and veg provide vitamins, minerals and fibre, with little fat. Another reason is: *Fruit and veg are high in what are known as antioxidants, which protect the body cells against damage that could lead to heart disease and cancer.*

Reminding the user about old tips is useful, as it provides consistency in the dialogue, and it allows old advice to be reconsidered in new context. But providing further advice allows the dialogue to move on. The new tip then provides the new context, with all the conversational options applying to it.

If the user rejects a tip (No Way!), then the system's response depends on whether the tip was providing a supporting argument for another. If so, it will present alternative arguments. If not, or if there are no alternative arguments, it will simply return to the previous tip context:

> OK, so you don't agree with: You should eat 5 portions of fruit and veg.
> Let's go back to: *Add salad to sandwiches, or choose ones with added salad.*

4.4 Example

The above model, although technically simple, allows for quite complex dialogues. The following is an example illustrating the various points above. The user has selected a tuna sandwich for lunch. User responses will be given in bold.

> You selected a tuna sandwich. Here's a suggestion: *If you make your own sandwiches, try to use thick cut slices of bread.*
> **Why?**
> Here's why: If you make your own sandwiches, try to use thick cut slices of bread. *Starchy food (bread, pasta, rice, cereals, potatoes) should be the main part of most meals and snacks. Eat lots of them.*
> **But..**
> Why are you unsure about: *Starchy food (bread, pasta, rice, cereals, potatoes) should be the main part of most meals and snacks. Eat lots of them*
> - I don't want to gain weight.
> - My diet is OK as it is.

I don't want to gain weight.
You said: I don't want to gain weight. *Bread, pasta, rice, cereals and potatoes are not high in calories, provided you don't add too much fat or sugar.*
OK!
OK, so remember: Bread, pasta, rice, cereals and potatoes are not high in calories, provided you don't add too much fat or sugar. Let's go back to: *Starchy food (bread, pasta, rice, cereals, potatoes) should be the main part of most meals and snacks. Eat lots of them.*
OK!
OK, so remember: Eat lots of starchy food. Let's go back to: *If you make your own sandwiches, try to use thick cut slices of bread.*

The system will then suggest other tips, each of which can be followed up in a similar way. At the end of a session the system lists the tips which have been accepted (by clicking OK!) by the user. These can be printed out if desired.

4.5 Implementation

The system is implemented in Prolog, with small Perl scripts providing the interface with the WWW. The HTML code is dynamically generated by the program in response to the user's selections.

The system is re-started to produce every screen. Most state information which we want to keep track of (e.g., list of tips already used, meal items selected) are stored in a file. Unique session numbers are maintained for each user, and simultaneous users' data will be kept in separate session files. However, the stack of tip contexts is passed as an argument in the URL, so that we can be sure that the use of the 'back' button on the browser does not upset this context information. The previous tip, and the user's selected button press (e.g., But..) are also passed as arguments in the URL.

The previous tip, stack of tip contexts, session numbers, and button press are passed as arguments to the main Prolog procedure that outputs the appropriate HTML. The selection of tips (etc) within this procedure will depend on the additional user data loaded from the session file.

5 Evaluation

The system was evaluated with relatively expert users, in order to obtain good feedback to guide the development of the system. Users were recruited from three sources: a mailing list on consumer health informatics; the sci.med.nutrition newsgroup; staff and students in the researchers' academic department. After using the system, they were requested to fill out a short questionnaire, containing both questions concerning their impression of the system, and personal questions on their diet etc. Altogether 152 sessions were recorded (but with some users initiating several sessions), and 40 questionnaires completed. There was a roughly equal balance of users from our three sources (newsgroup, mailing list, and department). 55% of our users were in the 20-30 age group, and 57% were

British. 95% felt that their diet was already either good or OK as it was, and 85% were at least trying a little to improve their diet. The majority (90%) of users found the system easy to use, with few navigation problems. It made 62% think about their diet, and 42% said they might improve some aspect of their diet as a result. 60% found some of the tips helpful.

The most positive comments came from those concerned with health promotion themselves, who appreciated the needs of our target audience, and the difficulties in creating simple, interactive nutrition systems. However, some users found it over simplistic, and were affronted by some apparent assumptions the system makes about their diet – they might be advised to cut out sugar in coffee for example. These tips (with implicit assumptions) were taken directly from leaflets, and needed rewriting for an interactive environment where many users expect tailored of advice.

Analysis of traces of system use revealed that many people did not press the Why?/But.. options much, so missed getting basic information supporting and reinforcing the tips. Presenting small chunks of information, and leaving the initiative with the user, has problems. Some users suggested that the system should be asking more questions as it went (keeping the initiative). This approach would mirror more closely the style of the human nutritionists dialogues, where most of the nutritionists contributions ended with a question.

Based on feedback from these users we have completed a revised version[3] with the following features:

- An initial questionnaire on attitudes to diet change, cooking habits etc.
- An initial page of personalised advice based on this questionnaire.
- Pages of advice tailored, in very simple ways, to user characteristics.
- Tips that may not apply (e.g., user may not take sugar in coffee) are now prefixed with 'Do you currently do X? If so, here's a suggestion.'.

These extensions involved adding a few further features to our tip knowledge base. For example, we now have statements such as:

```
tipfor(t036, cook).
tipif(t095, 'Do you currently take sugar in your tea/coffee').
```

While we have not yet evaluated this version formally, feedback from people accessing the site and filling in the questionnaire is positive.

6 Conclusion

We have described a new conversational model for computer-based health promotion, and an implementation for simple nutrition advice. The basic framework is simple, but can easily be extended and adapted. The tip knowledge base is separate from the dialogue module, so we can independently develop new knowledge bases in other domains, or vary the way the tips are presented in dialogue (e.g., to ask more questions of the user, or to always include supporting information).

[3] http://www.cee.hw.ac.uk/~alison/meals2/start.html

Our model could also be developed to allow further personalisation, such as in the arguments selected to support a tip. We have developed a more complete computational model of everyday argumentation [3], based on a theory of rhetoric [8], which could support this.

To use the model effectively in health promotion we would want to make the use of the system just one part of a healthy nutrition intervention. A conversational system such as this could be used in combination with quizzes and multimedia presentations, allowing practical and factual information to be given in a motivating and interactive manner, based on practical goals for change.

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