Toward a Systematic Understanding of Suggestion Tactics in Persuasive Technologies

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Abstract. The unique capabilities of mobile, context-aware, networked devices make them an interesting platform for applying suggestion in persuasive technologies. Because these devices are nearly always with their owners, can sense relevant information about the context of their use, and nearly always have network access, they enable the principle of *kairos*, providing the right information at the best time. Relatively little work has examined providing opportunistic, right-time, right-place suggestions or notifications that encourage people to change their behavior. This paper first discusses some of the challenges facing designers incorporating suggestions into their persuasive technologies. We then review a set of relevant persuasive technologies, focusing primarily on technologies in the health domain. We then identify a design space that represents tactics for building persuasive technologies, particularly suggestion technologies. We then explore how this design space of suggestion tactics can be used to evaluate, compare, and inform the design of new persuasive technologies.

Keywords: Mobile information systems, persuasive technologies, behavior modification.

1 Introduction

One billion adults worldwide are overweight, and 300 million of these are clinically obese [9]. These numbers demonstrate a global epidemic—one whose victims suffer from heart disease, stroke, hypertension and diabetes. Many of these diseases are provoked or aggravated by lifestyle choices related to diet and exercise. It has also been argued that technology has played a role in allowing many adults to maintain a sedentary lifestyle. As researchers, we feel it is important to develop technologies that encourage a healthy lifestyle. Persuasive technologies can play an important role in encouraging healthy behaviors.

Fogg identifies seven strategies for persuasive technology tools: reduction, tunneling, tailoring, suggestion, self-monitoring, surveillance, and conditioning [3]. When we reviewed existing persuasive technologies related to encouraging a healthy lifestyle, we found that some of these strategies were incorporated more often than others. In particular, we believe that suggestion technologies, which provide an

intervention at an opportune moment for maximum effectiveness, are relatively under-explored in existing persuasive systems. Existing examples of suggestion tend to be peripheral, with the technology occasionally using suggestions but primarily employing a strategy like self-monitoring, reduction or tailoring.

We are drawn to better understand this relatively under-explored aspect of persuasive technology by the fact that mobile, context-aware, networked systems are increasingly enabling the principle of *kairos*, presenting the right message at a time when it can be most effective. Context-aware devices can detect an appropriate context in which to pursue a persuasive intervention, and increasing device capabilities provide increasingly flexible means of pursuing that intervention. In addition, research on the nature of interruptions and when interrupting notifications will best be heeded offer to improve the effectiveness of suggestion technologies [2]. Ideally, these technologies can be combined to create effective suggestion technologies that provide appropriate information at the right time, in the right way.

As noted by Fogg, it is important for the community surrounding persuasive technologies to examine both strategies and tactics. Fogg elaborated the various strategies, but there is a need to further refine the possible *tactics* – how the strategies are realized – that will be most effective. The number of potential tactics is infinite, and the tactics available will change over time as available technologies change. However, the choice of tactic to use for a particular product will be important to the success of the product, and we should certainly be able to start enumerating what challenges and benefits have been associated with different tactics.

In this paper, we first explore some of the challenges we believe researchers and designers face when applying suggestion in persuasive technologies. We then present an analysis of the design space for tactics to implement suggestion, specifically focusing on mobile, context-aware, networked systems. This analysis of the design space is based on an exploration of persuasive technologies in the domain of healthy living. We then examine suggestion-based interfaces in the context of this design space. As a tool for researchers and designers, our analysis provides a set of dimensions to consider when designing, comparing, and evaluating persuasive technologies. We can also use this understanding of the design space to identify potential approaches that may have been overlooked.

2 Related Work

Fogg [3] describes seven types of *persuasive technology tools,* each of which employs a different *strategy* (or *principle)* to change attitudes or behaviors. He discusses their underlying principles and provides examples of each. We are interested in further exploring what in this framework is referred to as a *suggestion technology*—tools that employ the suggestion strategy. Fogg mentions that a persuasive technology product usually incorporates multiple tools, each informed by a different strategy; we believe that many of these strategies overlap, and later we discuss how other strategies are closely related to suggestion strategies.

Khaled et al [4] have investigated the role that culture may play in the effectiveness of persuasive technologies. They note that the distinction between individualist and

collectivist cultures are the most significant, and in their analysis, believe that most of the persuasive tools Fogg presents are more likely to be effective in an individualist culture. The United States is a primarily individualistic culture. The only type of persuasive tool that Khaled et al believe may be more effective in a collectivist culture is that of suggestion. The reason for this belief that the power of suggestion may be more effective in a collectivist culture is that collectivists are "already used to acting upon the suggestions of others, this may mean that they will be more willing to accept suggestions made by persuasive technologies, especially if the persuasive technologies are perceived as in-group members", while "individualists tend to look to their own values and priorities to help them decide upon courses of action to take." As we discuss later, this may contribute to the lack of focus on suggestion technologies in general.

Mazzota et al [5] are researching the role of emotion and logic in argumentation strategies for persuasive dialogues, specifically in the domain of eating well. Their preliminary research shows that the most persuasive dialogs employ positive rather than negative arguments, that it is very uncommon for people to employ a purely logical argumentation strategy, and that most arguments appealed to emotional rather than logical elements. In their evaluation, emotional dialogs employing positive arguments were most persuasive, and adapting the message to the recipient's characteristics was also found to be important.

Bickmore et al [1] have researched the role of emotional and relational skills in a tool to support a health behavior change intervention for physical activity adoption. Their tool incorporated anthropomorphic avatars, which enabled them to explore the use of both verbal and nonverbal behaviors in the interface. The experiment was a 30-day trial consisting of three groups of subjects, in "relational", "non-relational", and "control" groups. They found that there wasn't a significant difference between the amount of physical activity performed by subjects in the "relational" versus "non-relational" groups; however, the subjects interacting with the relational agent reported a significantly greater desire to continue working with the relational agent.

Finally, we describe persuasive technologies for improving personal health. These are technologies that we included in our analysis; as there is not enough room to enumerate and describe all of them, we will use a few examples throughout the paper.

Nawyn et al. [6] has incorporated some of these ideas into a system to help people become more aware of and modify a very specific behavior—television watching. ViTo is an enhanced remote control for a media center that tracks a person's television watching goals. Once the daily goal has been reached, ViTo notifies the watcher and suggests alternative activities to pursue. Thus, they suggest replacing an "undesirable behavior" (watching TV) with a "more desirable behavior" (reading, listening to music, etc), and thus breaking the habitual cycle.

MPTrain [7] is an augmented music system for runners that integrates a heart rate monitor with an MP3 player. The runner specifies their target heart rate for different intervals during the run. Sensors monitor the runner's heart rate and pace throughout the run. Towards the end of a song, the system determines if the runner's heart rate is faster or slower than they wanted to achieve, and chooses the next song to be one with an appropriate number of beats per minute—either a slower or faster tempo as appropriate.

Nike+iPod [8] uses an iPod that communicates wirelessly with a sensor in the runner's shoe to help the runner keep track of their current pace and distance. With this information, the runner can adjust his workout as appropriate. The runner can also play a predetermined playlist to help guide the pace of the workout. After the workout, the runner connects the iPod to his computer, where the last workout's information is aggregated with past workout data. The user can track goals, challenge friends, and see how one run compare with others.

3 Importance and Challenge of Suggestion Technologies

First, we review seven of the persuasion strategies described by Fogg [3], and summarize them in Table 1. A suggestion technology says the right thing at the right time to be most effective at changing one's behavior. If someone has a goal of walking more steps in a day, an appropriate time to remind someone of this goal is when they are standing waiting for the elevator, or perhaps when they are driving and can be reminded to park further away from their destination before they reach the destination. Sometimes, the appropriate suggestion is retrospective—if someone is reviewing their progress for a day, a suggestion might be to take more walking breaks rather than sitting at their desk.

We define a suggestion technology as one that incorporates active notifications that contain information that allows someone to do something they might not otherwise have done. We would not consider a simple pedometer to be a suggestion technology, since it passively provides information. If it beeped every so often to remind the wearer to walk more, then it could be considered a suggestion technology.

The potential use of suggestion technologies spans a wide range of applications. One can imagine a suggestion technology to support elder care, reminding forgetful seniors when to take medicine, encouraging daily fitness routines, and helping to keep in touch with friends and family. Another application is health and fitness, where context-aware suggestion technologies can help individuals "stuck" in their routine identify where they may change, *in situ*, by making suggestions at the moment when he can best act on it. In this way, the suggestion technology can help them reframe the way they see the world and incorporate new behavioral strategies into their lives. Personal finance, energy conservation, and driving are examples of domains that may

Table 1. Review of Persuasive Strategies

Persuasive Strategy	Short Description
Reduction	Making a complex task simpler
Tunneling	Guided persuasion; giving control over to an expert
Tailoring	Customization; providing more relevant information to individuals
Suggestion	Intervene at the right time with a compelling suggestion
Self-monitoring	Automatically tracking desired behavior
Surveillance	Observing one's behavior publicly
Conditioning	Reinforcing target behavior

benefit from an effective context-aware, mobile suggestion technology.

Few persuasive technologies take advantage of suggestions as the primary strategy for persuading. There are a number of reasons for this—first, that context-aware mobile systems are fairly new, and the technology is still being explored and its limits are still being tested. An effective suggestion strategy using a context-aware mobile system will require the system to be robust and predictable. It is also possible that culture certainly plays a role in the limited incorporation of suggestions into persuasive technologies. As discussed in [4], users in cultures that focus on the progress of individuals over the progress of the community, as is the case in the United States, will be less likely to follow a given suggestion. Therefore researchers in the United States may have a bias against building suggestion technologies. Informal conversations with designers of persuasive technologies for health are consistent with these challenges.

3.1 Overlapping Persuasive Strategies

Fogg's strategies for persuasive technologies are fairly well-defined, but there exist overlaps between the strategies. Here, we discuss strategies similar to the suggestion strategy.

Tunneling versus suggestion. Tunneling can be viewed as being at the extreme end of the spectrum of possible suggestion technologies. Tools that employ a tunneling strategy attempt to initially remove the subject's autonomy around a certain behavior, and dictate what that person should do. One common example is a personal trainer, to whom the subject has decided to listen to—more or less unconditionally—in order to reach a fitness goal. Rather than being required to learn about different ways to attain her goal, she gives herself over to the trainer, and does what she's told. This is pure suggestion—being told what to do and when. It is possible that the only difference between tunneling and suggestion is that the subject has given up autonomy and committed to following the suggestions from someone else.

Self-monitoring versus suggestion. Self-monitoring tools make it easier for someone to monitor their behavior. A suggestion system is likely to be monitoring what a user is doing, and making suggestions based on those inferences. If a suggestion incorporates some measure of a targeted behavior in the message, such as "if you walk to your next destination you'll reach your step goal for today", that's helping the person monitor their behavior.

Reduction versus suggestion. Reduction tools simplify a specified task by taking away complexity or reducing barriers. When a suggestion tool enables decision making on-the-fly, it begins to look more like a reduction strategy. Collecting information and making it easier to visualize the elements of a decision reduces the cognitive load on the user. For example, rather than navigating to web sites to find current traffic conditions, the persuasive system can proactively collect relevant data and suggest the path to be taken automatically.

Overall, the use of suggestions in a persuasive technology appears to be an under-utilized approach that may be very valuable. We want to explore this issue. In the next section, we will outline how we will go about doing so. Our goal is to develop a

set of guidelines to realize suggestion-oriented tactics in persuasive systems and thereby help future designers to more easily construct robust and useful systems.

4 Dimensions of the Suggestion Tactic Design Space

As a step toward systematically understanding suggestion tactics, we have identified dimensions that define the design space. To do this, we chose some persuasive technologies, most with the goal of improving health behaviors. Although we are primarily interested in suggestion technologies, we ensured that we chose a balance of technologies that were specifically designed to incorporate a suggestion strategy, and others that did not. We reviewed these technologies, and identified a list of dimensions that differentiated them. We then performed a review of the persuasive technology literature to identify other dimensions that we deemed important, even if there was no evidence of differentiation among the technologies on these dimensions.

The dimensions that describe the design space loosely break out into two categories: technological and content. The technological category is the *how* or the medium of the system: how the context sensing is done and how a message or information is communicated to the person. The content category is the *what* of the system: what content is presented to the person, such as general versus specific feedback, incorporating affect into the message, and applying logical versus emotional appeals to the person. Table 2 shows an overview of the design space, and we discuss each dimension in more detail below.

Once we identified the list of dimensions that describe the design space of suggestion tactics, we identified the placement of each technology in that multi-dimensional space. We did this by defining a *tactic profile*, which simply describes each dimension value for a given technology and defines where the placement of the technology in the design space. We then analyzed the tactic profiles of each technology to find any consistencies, inconsistencies or patterns. We also explored some example designs, comparisons, and evaluations, some of which we discuss later.

4.1 Technological Dimensions

Display or feedback mechanism. The notification mechanism for a suggestion will be embedded in one of three locations. First, it can be *embedded* in the appliance or technology that is being used, such as ViTo, where the feedback is presented in the remote control. This has the property of being special to the device, and constrained to displaying information primarily about that appliance only. The other two locations are generic displays that can potentially provide information or notification from multiple sources. Second is a *personal device*, such as a cell phone, PDA, or watch with a display. Third is an *environmental display*, such as an interactive wall, or a large wall display. Additionally, some technologies include more than one display or feedback mechanism, such as another, more capable interface that allows more detailed information to be displayed. One example is the Nike+iPod. During a run, the iPod Nano provides only the most relevant information, such as pace, time run, and distance run. However, after the run, the data is aggregated and runners have access to

Table 2. Overview of selected technologies

Technological Dimensions	Subtleness			Display			Notification Modality						Context Source			Time-liness		Interac-tivity	
							Visual			Audible									
	Subtle	Obvious	Requires Acknowledgement	Embedded	Personal	Environmental	Text	Graphical	Animated	Spoken Text	Auditory Alert/Sounds/music	Tactile	Environmental	Personal	Manual Input	Just-in-time	Retrospective	Interactive/Dialog	Passive
MPTrain		X			X						X			X		X			X
Nike+iPod		X			X		X	X		X	X			X		X	X		X
ViTo	X		X	X			X				X		X			X		X	

Content Dimensions	Specificity		Affect			Adaptive Affect	Argumentation Strategy		Overtness		Explicitness		Social Components			
															Public	
	General	Specific	Neutral	Positive	Negative	Uses Adaptive Affect	Logical	Emotional	Overt	Vague	Informative	Provocative	Personal	Team	Anonymous	Non-anonymous
MPTrain	X		X	X			X	X		X	X		X			X
Nike+iPod		X	X				X			X	X		X	X		X
ViTo		X		X				X	X			X	X			

a website that lets them track their workouts and goals over the past few weeks or months.

Notification modality. This dimension describes which sensory inputs are used to present the suggestion to the subject. For our analysis, we break this into *visual*, *audible*, *tangible/tactile*; we then further specify the categories. The visual category is further distinguished by text, graphics, or animations, and the audible category consists of spoken words and tones or chimes.

Sensor or Context Source. This dimension describes how the subject's relevant context is detected. We identified three context sources: *environmental*, *personal*, or *manual input*. These values are not exclusive and may be combined in one technology. Environmental sensor or context detection is embedded in the environment, including appliances. They are able to detect things like "someone turned on the TV", "someone is using the faucet", or when combined with a personal context source, who just turned on the TV or used the faucet. Personal context detection is when the sensors are in relation to the individual, and activity and context are detected for that person only. There may be some interaction with environmental sensors (such as a Wi-Fi access point to compute location, where the person carries a personal device that detects the access points located in the environment), but the sensing is person-centric. Context that is manually input is explicitly provided by someone who is in a position to observe and specify it to the system. This may be the

case when it's difficult to automatically detect a context of interest, such as what food someone is eating.

Timeliness. This dimension describes whether a suggestion is provided *just-in-time* or *retrospectively*. Suggestion technologies are about making suggestions at the most effective point in time. If a technology that enables one to reflect on data about their behavior throughout the day, that period of reflection may be an opportune moment to suggest future behavior changes. An example of a retrospective condition is that you have gathered all this activity data for the day (or some period of time), and are reviewing it. The suggestion technology points out instances in time when you could have done something differently. This particular item links to both a self-monitoring strategy (via the review of behavior & identifying how/when to change it) and a conditioning strategy, where the timing can be used to provide positive feedback when a desired behavior is exhibited. One tool might incorporate both—immediate feedback when appropriate as well as suggestions when reviewing data.

Interactivity. This dimension refers to whether messages are simply presented, such as a message appearing on a display and then disappearing, or if they require some sort of acknowledgement or input. In the case where a designer prefers the technology to be minimally intrusive, a message won't require explicit acknowledgement from the subject. However, a designer may prefer to make technology require some action on behalf of the subject to make him more aware of his behavior. This interaction may simply be clicking a button saying "I choose to not follow this suggestion right now", or launching into a dialogue with the system which is trying to capture more information about the subject's current situation.

Subtleness of notification. This refers to the technological subtleness of the message-notification system, rather than the content subtlety. This technological subtlety is a continuous variable, with one end of the scale being a very subtle message, perhaps a peripheral light that flashes different colors or patterns to communicate something, and the other end of the scale being a very noticeable message that the subject is less likely to miss noticing or misinterpret. One example is the eWatch from CMU, which uses sensors to determine levels of interruptibility of the wearer, and tailors notifications appropriately.

4.2 Content Dimensions

Message specificity. This dimension indicates whether the messages tend to be relevant yet vague, or very specific. This is best explained with an example. An example of a vague yet relevant message is "good job", displayed when a person meets their activity goal for the day. An example of a specific message is "You've met your goal every day for the past 6 days—excellent!" The importance of this dimension is that messages that are too specific may be less appealing to users over time, but messages that are too vague could be misinterpreted.

Affect. Message content can be designed to minimize affect, or adopt a positive or negative affect. As we've discussed earlier, positive affect is more likely to engage the users.

Adaptive affect. This dimension indicates whether the tool incorporates adaptive affect into the messages. Technologies that incorporate this dimension were un-represented in our analysis, although research indicates that adapting affect in response to the recipient's state results in a more trustworthy system, and enhances the relationship between the recipient and the system. However, affect is still difficult to accurately detect.

Argumentation strategy. This dimension indicates whether the tool employs a logical or an emotional argumentation strategy for persuading. An example of a logical argumentation is to simply report on one's behavior (current step count is 2800, daily goal is 8500). An emotional argumentation strategy appeals to the recipient's emotional desire for reaching a goal. Rather than focusing simply on the logic ("you won't reach your goal if you don't walk more"), messages can appeal to the emotion of reaching a goal ("remember, this goal will help you get more fit so you'll look great on the beach in a month!").

Overtness. This dimension describes the overtness of a suggestion or message. An example of an overt message is "Parking further away allowed you to add 2800 steps to your daily goal—good job!", while a vague message might be "Good job—Keep working towards your goal!".

Explicitness. This dimension indicates whether a tool is informative or provocative in the suggestion. A simple example of an informative message is a pedometer which displays current and goal step counts. The suggestion is implied, rather than explicit. An example of modified pedometer that uses provocative messages may suggest going for a short walk, to ensure you meet your goal today.

Social components. This dimension describes the level of social integration the tool supports. Suggestions can be *personal*, where the information is provided only to the wearer, and no one else can see; *team-oriented*, where your information is shared within a known group or social network; or *public*. For public suggestions, the information may or may not be *anonymous*. In the case of not-anonymous, everyone can see your information, and knows that it comes from you. Anonymous public content refers to a situation where summary, anonymous overviews of the information are provided to everyone, but specifics about one person's performance are unclear. With this type of information, one can determine how personal data compares to the group as a whole.

5 Discussion

We were motivated to pursue this work because we thought it would be a useful tool for researchers and designers to design, compare, and evaluate suggestion tactics employing context aware mobile technologies, as well as identify areas of potential promise. In this section, we will describe some observations we had about the design space of these tactics and describe how this conception of the design space may be used to design, compare, and evaluate.

5.1 Comparing Two Technologies

This tool can be useful in comparing two technologies, particularly when used in conjunction with Fogg's guidelines. For an example comparison, we look at two technologies designed to support achieving running goals: the Nike+iPod and MPTrain.

The overarching goals of the two technologies are similar. However, they approach them differently. Nike+iPod provides current data throughout a run, and therefore requires the runner to be aware of their goal for that run and choose to adjust their pace using the feedback on the display to achieve that goal. MPTrain requires the runner to specify the workout in terms of intensity as measured by heart rate. It does not explicitly provide either the runner's current heart rate or target heart rate, but attempts to persuade the runner to change his running pace by playing music that has appropriately more or fewer beats per minute.

The Nike+iPod combines two commercial products for extra benefit. The MPTrain is a research project focusing primarily on whether an adaptive playlist can make it easier and more pleasurable for someone to reach their running goal. They both have the overarching goal of wanting to help people meet their running goals. However, the MPTrain project could dovetail nicely with the existing Nike+iPod.

There are two primary purposes one might have to compare the two technologies. The first is motivated by competition—if the MPTrain people are likely to try to build a product to compete with Nike+iPod. The other is motivated by collaboration, or working towards incorporating the MPTrain technology with Nike+iPod.

In either case, the comparison is mostly about how effective MPTrain is, and if it could be a substantial enough addition to a Nike+iPod system to support either a beneficial collaboration, or to recognize serious competition. Our comparison using this tool should be along the lines of how well the two technologies complement each other.

For this example, a quick comparison of the profiles indicates that the two technologies are likely compatible, and may be a good match. Both technologies are embedded into a personal device, but the Nike+iPod has a secondary display that provides another persuasive component to the overall project. The Nike+iPod provides multiple modalities of notification, while the only modality for MPTrain is the music. The other major difference we see is a difference in the specificity of the message. The Nike+iPod clearly displays the current pace, time and distance run, while the MPTrain simply plays music with a different number of beats per minute. The runner would likely need to be fairly sophisticated to determine what the change

in music is revealing about the current run. Finally, the MPTrain also may contain an affective component, as different music can clearly invoke varying affect. Playing music with a high number of beats per minute could invoke a more positive affect than music with a low number of beats per minute.

5.2 Evaluating a New Persuasive Technology

The benefit of this tool for evaluating new persuasive technologies is primarily by providing a framework for which an evaluation occurs. One could imagine a situation where a new persuasive technology is built, or we could even use an existing persuasive technology. In any case, we want to understand how well the tool is working, and make it as effective as possible. If the profile of the existing technology indicates that it is neutral in affect, then we can attempt to incorporate positive affect into the device, and re-evaluate. Perhaps reviewing the tactic design space, along with the discussion about tradeoffs for each dimension and the profile, will help to identify where common problems might occur and potentially suggest improvements.

5.3 Identifying Fruitful Opportunities

As this design space becomes more populated both with persuasive technologies implementing these tactics and new technologies that enable these tactics, it will become easier to identify areas in the design space that are providing fruitful opportunities. From our initial populating of the design space, we discovered fairly few technologies that strongly incorporate adaptive affect, positive affect, or an emotional argumentation strategy. Adaptive affect is still a difficult technical problem, but positive affect and emotional argumentation strategies are two tactics that should be able to be incorporated fairly effectively.

5.4 Informing the Design of a new Persuasive Technology

This tool could be used to help inform the design of new persuasive technologies. One way to do this is to use the listed components as purely generative. There might be some constraints to a new project, such as what sensor platforms and displays one has available for use. Or, one might choose parameters for the new product based on the desired effect for each component. We believe that once this design space is more specified and we have spent more time placing existing technologies within the space, information about tradeoffs for each component choice will become more substantial.

6 Future Work

One important area of future work is exploring, expanding on, and documenting tradeoffs to consider when choosing a design point for each dimension of the tactic design space. We have begun this by collating related work, which informed the

choice of some dimensions. Further work would include reviewing a more extensive collection of persuasive technologies and analyzing the tradeoffs each one experienced.

We also will further specify dimensions of the design space. One example is to incorporate specific approaches for integrating affect into a persuasive technology. Some of the dimensions we noted did not have enough examples of work in the form of actual systems to fully populate the dimension. We will need to rely on related research that is focused on exploring one part of a potential system, rather than an existing, complete system.

Finally, we intend to use this tool to inform our own work in the area of designing, building, and evaluating new persuasive technologies. As we go through this process, we believe this tool will be invaluable for helping to position our work in relation to other work, inform our design rationale, and provide a clearer path for evaluation.

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