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User Control and Its Many Facets: A Study of Perceived Control in Human-Computer Interaction

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People prefer to be "in control", but what this means in human-computer interaction is not always clear. The research paper here examines several variables known to contribute to a sense of control in human-human interactions and tests them in the context of human-computer interactions. Study 1 examines the contribution of choice and domain information to perceived control. The results suggest that cultural background moderates the relationship between choice and perceived control. Whereas Westerners responded positively, Asians responded negatively to increased choice. Westerners who were given more choice also reported the application was more difficult to use. This suggests that there might be a tradeoff between perceived control and ease of use. Study 2 examines the contribution of source credibility and user orientation to a sense of control. The results suggest that source credibility increases perceptions of control, but also increases anxiety about failing. Implications for interface design are discussed.

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A Study of Perceived Control in Human-Computer Interaction

"[With direct manipulation, users] can more often and more rapidly accomplish their goals while preserving their sense of control and accomplishment." – Ben Shneiderman

"[With] direct manipulation, nothing happens unless a person gives commands... the computer is merely a passive entity... it provides little help for complex tasks or for carrying out actions..." – Pattie Maes

"If untrained consumers are to employ future computers and networks effectively, direct manipulation will have to give way to some form of delegation. [With] software agents, which 'know' users' interests and can act autonomously on their behalf... people will be engaged in a cooperative process in which both human and computer agents initiate communication, monitor events and perform tasks to meet a user's goals." – Pattie Maes

"Designers [using the agent metaphor] believe that they are creating something lifelike and smart, however users may feel anxious and unable to control these systems." – Ben Shneiderman

(Maes, Shneiderman, & Miller, 1997)

For the last decade, there has been a raging debate between those arguing for interfaces in which users retain complete control through direct manipulation and those arguing for agents that act on behalf of the user. Those in the direct manipulation camp argue that users are uncomfortable about relinquishing control whereas those in the agent camp suggest that agents can simplify people's lives by distilling and filtering information. But, to date, there has been little empirical work to establish what contributes to users' sense of control in an interface. In this paper, I present several empirical studies designed to help us understand the conditions that contribute to perceived control in human-computer interaction.

One of the reasons that user control has warranted such debate over the years is because perceived loss of control can be costly. People who feel out of control can experience more anxiety and stress (Deci & Ryan, 1987), more anger and hostility (Brehm, 1966), and lower self-esteem (Rodin, 1990). If control appears to be in the hands of someone else, people can feel negatively about that entity and work to distance themselves from them (Depret & Fiske, 1993). When the entity is a technology, such distancing could lead to reduced use and, ultimately, less acceptance of the offending technology. Therefore, designers of human-computer interfaces need to consider the users' sense of control as an important determinant of the overall usability of the system. Although there is a vast literature in social psychology that explores the causes and consequences of control in human-human interactions, few of the findings have been applied to understanding human-computer interaction. I attempt to bridge this gap by borrowing

psychology to create and test a model of how control might be experienced in human-computer interaction.

The concept of "control" is one that most people can describe easily, but the scope covered by the construct is broad and formal definitions are widely divergent. For the purposes of this work, I have narrowed the scope to focus on perceived control of things outside of the self. In human-human interaction, scholars have emphasized the ability to direct activities toward the achievement of a person's goals (Rodin, 1990; Skinner, 1995; Weisz, 1986 for example). Burger (1989) further suggests that a person must see the event as significant to experience a sense of control. Building on the work done by these researchers, I propose the following working definition for control in the human-computer interaction context.

> *"The perception that one's behavior significantly alters outcomes by producing desired and preventing undesired events."*

A survey of the social psychology literature on control suggests that there are numerous variables that effect people's perception of control. These include characteristics of the task, of the context in which people are working, and of the individual. The work reported here examines several task characteristics by embedding these characteristics in the design of a computer interface used to perform the task. These design characteristics include amount of choice and amount of task information when performing the task, and the extent to which the interface establishes itself as competent and oriented toward the user's goals. In addition, this work explores the extent to which cultural differences moderate the relationship between these design characteristics and perceived control.

Choice and Information

The extent to which a person is able to choose can have a strong effect on a person's sense of control. In fact, choice is so intimately tied with the concept of control that it is often used as the operationalization of control in empirical research. Peoples' experience of control increases when they can exercise choice with regard to the onset, timing, occurrence, and type of event (Thompson, Sobolew-Shubin, Galbraith, Schwankovsky, & Cruzen, 1993). People's experience of control can increase even when they are given choices in purely chance situations (Langer, 1975). Langer refers to this phenomenon as the "illusion of control," a bias whereby people behave as though chance situations become skill-based when the task takes on elements of a skill-based task (e.g. making a decision). Therefore, it appears that providing users with the opportunity to make decisions and choices will increase their sense of control even when the situation is clearly outside of their control.

> *H1: Users will perceive that they have more control when they have more choices available to them in an interface.*

"Information" refers to the information available to people about the causes of their desired actions and the effect of their behavior on those causes. When people are at least

moderately knowledgeable about what is required to achieve a goal, they feel more in control (Thompson, 1991). Rosenbaum and Smira (1986) have suggested that increased knowledge helps people to monitor and regulate their own responses and reactions thus producing a higher level of control over their own behavior. Even a small amount of familiarity with the elements of a task increase a sense of control (Langer, 1975). For example, in a study by Langer (1975) people felt more in control when they were given a card with a letter than when given a card with an abstract line drawing even though the image on the card had no bearing on the outcome of a gamble. These findings suggest that knowledgeable users and users with information about the domain will feel more in control. To the extent that an interface provides relevant domain information, novice users should feel more in control.

H2: Users will perceive that they have more control when they have more domain information available to them in the interface.

Alternatively, information and choice may both be required to generate a sense of control. That is, people may feel less in control when they are required to make choices in the absence of information. People feel more in control when they are able to positively effect the outcome of an event (Skinner, 1996). But, in the absence of information, people may feel less in control if required to make choices when their ability to understand the implications of their choices and make decisions accordingly are limited.

H3: Information will moderate the relationship between choice and control such that increased choice will be positively associated with perceived control in high information conditions and negative in low information conditions.

Credibility and Orientation

Another determinant of a person's sense of control is the extent to which they feel that they will be successful at achieving their goals (Thompson, 1991; Wortman, 1975). At times, depending upon another "agent" who can lend expertise (e.g. a physician, realtor, broker, etc.) can augment a person's personal power to achieve their own goals (Antonovsky, 1979). But, these relationships can be delicate and depend heavily on trust between the user and the agent. To retain a sense of control, people need to be assured that the agent is both competent to perform the task and trustworthy to act on the individual's account (Antonovsky, 1979). Therefore, an interface that establishes itself as both credible and oriented toward the users' goals should positively contribute to users' sense of control.

H4: Users will perceive that they have more control when an interface establishes itself as credible and oriented toward the user's goals.

Cultural Differences

Control beliefs and control motivations may differ based on cultural background (Triandis, McCusker, & Hui, 1990; Weisz, Rothbaum, & Blackburn, 1984). In a recent series of experiments, Sethi and Lepper (1998) established that being able to make choices is less intrinsically motivating for people from Asian as compared to Western cultures. Along with others, they argue that Asians value collectivism and interdependence whereas Westerners value individualism and independence (Markus & Kitayama, 1991; Sethi & Lepper, 1998; Triandis et al., 1990). Rather than viewing choice as an opportunity reinforce their own identities, Asians may consider choice a burden with the potential of causing unwanted differentiation from others.

H5: Cultural background (Asian vs. Western) will moderate the relationship between choice and perceived control with Asians responding negatively to increased choice and Westerners responding positively to increased choice.

Recent work on perceived control has differentiated between extrinsic and intrinsic sources of control. Extrinsic sources of control include people's ability to control the process (Bandura, 1977; Heckhausen, 1977) or the outcome of a situation (Miller, 1979; Thompson, 1981). These lines of research focus on people's ability to act on things and people outside of themselves. Other research emphasizes peoples' ability to control their own thoughts, emotions, or perspectives about a situation (Averill, 1973; Fiske & Taylor, 1991). Because people from Asian cultures emphasize less individual control, they may also derive more rewards from intrinsic rather than extrinsic sources of control. For instance, Asians may be more motivated to change the way they think about a situation whereas people from Western cultures may be more motivated to change their environment. This suggests that users from Asian cultures may have more stable perceptions of control than those from Western cultures.

H6: Perceptions of control will be less effected by manipulations in the interface for Asians than it will for Westerners.

Overview of Studies

In this paper, I present two studies. The first study examines the relationship between choice, information, and perceived control. The second study examines the relationship between competence, orientation, and perceived control. Both studies use an experimental paradigm in which novices (relative to the domain and the computer interface) were asked to use a computer interface to perform an evaluation of a patient at risk for an episode related to congestive heart failure. The task and interface are described in detail in the description of study 1.

Both studies distributed Asian and Western subjects across manipulations so that cultural differences could be examined. The culture dimension was created by categorizing subjects based on self-reports of ethnicity. Subjects who reported Asian ethnicity were

categorized as Asian. All other subjects (Caucasian, Black, and Hispanic) were categorized as Western for the purposes of these two studies.

The two studies reported here rely on several measures of control. In addition to direct measures of control (described in detail in study 1), indices were created to measure two constructs that are theoretically linked with perceived control. The first construct is self-efficacy. Glass and Carver have argued that a person will feel in control if they see a relationship between their behavior and an outcome (1980). Self-efficacy is an important component of control because it captures peoples' perceptions about the link between actions and contingencies (Glass & Carver, 1980). The second construct is anxiety about failing. This construct is intended to measure peoples' anxiety about their ability to create "desirable consequences" (Rodin, 1990; Skinner, 1995). A third index for perceived information quality also was created. This index is intended to measure people's perceptions of and confidence in the information presented within the interface. All items and indices used as dependent variables in studies 1 and 2 are listed in figure 1 along with reliability scores for the indices.

Figure 1: Items and indices used to construct dependent variables in studies 1 and 2.

Index	Statements
Control	I felt that I was in control. I was able to approach the problem in my own way.
Self-efficacy (alpha=.62)	When I planned on doing something, I was able to make it work. I have a pretty good idea of how the assessment was calculated. I felt responsible for performing the task well. I felt discouraged while performing the task. (reverse scored) I felt good about my performance on the task. At some points, I felt like giving up. (reverse scored)
Failure Anxiety (alpha=77)	I felt anxious while performing the task. I was afraid I would get the wrong answer. The task was stressful I was anxious about getting the right answer. There were points at which I thought I was going to fail.
Ease-of-Use[a]	It was easy to use the diagnostic program.
Information Quality[a] (alpha=.80)	How helpful was the program's information? How relevant was the program's information? How much did you trust the program's information? How insightful was the program's information?
Confidence	How confident are you that this value is accurate?

[a] These questions (indices) were rated on a 1-10 (not a 1-7) scale with 1 being "not at all" and 10 being "extremely"

Study 1

Method

The goal of Study 1 was to examine the relationship between choice, information, and perceived control. The study was a 2 x 2 between subjects design with choice (low, high) and information (low, high) as dimensions. Participants were asked to evaluate a patient's risk of an episode associated with congestive heart failure using a computer interface.

Participants.

Participants were 60 male graduate students enrolled in technical disciplines (e.g. engineering, computer science, physics) at Carnegie Mellon University and the University of Pittsburgh. They were recruited through postings on physical and electronic bulletin boards and were paid $20 for their participation. Five participants were excluded from all analyses because they encountered technical problems when using the experimental computer interface.

Task

Participants were asked to assume that a relative of theirs was at risk of having an episode associated with congestive heart failure that might require medical attention. Participants were provided a description of the task, information about the patient's current condition in a "daily health evaluation form", and an interface (referred to as Heartech) on which to conduct an assessment. Heartech contained seven risk factors including weight, ankle size, food intake, heart rate, respiratory rate, respiratory depth, and agitation. The Heartech program required that participants use data from the daily health evaluation form to determine the values needed for the assessment program. In addition, participants were expected to use some historical information residing in the application database. To increase participants' perception of task importance and dependence on the interface, they were told that their answer would only be considered "right" if they got it within 20 minutes.

Choice Manipulation

Choice was manipulated within Heartech by varying the amount of predefined structure in the task. In the low choice interface, participants were presented with no menus. They were walked through the task screen by screen and were required to enter data into the data field at each screen. Participants could not go forward without entering data, nor could they go back to previous screens. In these conditions, participants were only able to enter data and continue forward, therefore they had very few choices to make while conducting the assessment. In the high choice conditions, participants were able to navigate through the entire range of options in Heartech through pulldown menus on the menu bar. They were able to go forward and backward through the system and were able

to change any information prior to running the Heartech analysis. In these conditions, participants had many choices about how to conduct the assessment. Appendix A provides an illustration of a Heartech screen in the low choice condition and in the high choice condition.

Information Manipulation

Information was manipulated within Heartech by varying the amount of domain information provided. In the low information condition, no specific domain information was provided. In the high information conditions, detailed information on congestive heart failure and on each of the seven risk factors was provided. These information screens were presented when Heartech was started (general information screen) and prior to each of the risk factor input screens. Appendix B provides an illustration of one of the Heartech information screens.

Procedure

Upon arriving at the laboratory, participants were asked to complete a survey which contained demographic questions. Subjects were randomly assigned to condition such that cultural background was balanced between the four study conditions. Subjects were then given written task instructions. The instructions explained that they would be asked to use some application software to conduct a risk assessment on a relative of theirs who was at risk for a medical episode related to congestive heart failure. They were told that they only had 20 minutes to complete the assessment and that they were going to need to make a decision about whether or not to take their relative to the hospital based on the assessment. The trip to the hospital was described as potentially dangerous due to winter storm warnings in the area. After reading the task instructions, participants were escorted to another area in the laboratory and seated in front of a computer. They were given a "daily health evaluation form" with current patient information and a pad of paper on which to take notes. Participants were asked to hit the return button on the keyboard when they were ready to begin the task. After completing the task, participants were escorted back to the desk area and given a survey asking them about their experience with the task. After completing the post-task survey, participants were debriefed and paid.

Dependent measures

The primary dependent variable of interest in this study was perceived control. Perceived control was measured with several items. Participants were asked to indicate their level of agreement with two statements about their perceptions of control. Ratings were made on a 7-point scale with 1 being "not at all" and 7 being "very much". The two statements were:

I felt that I was in control.
I was able to approach the problem in my own way.

These two items were highly correlated ($r=.44$, $p<.01$) and were averaged to create a single measure of perceived control, referred to hereafter as "control". Indices also were created to measure participants feelings of self-efficacy in performing the task and their anxiety about failing the task. Finally, participants responded to statements designed to measure perceived ease-of-use (single item), perceived quality of the information provided by the interface (index), and participants' confidence in the value that they generated using the interface (single item). All indices were based on participants' responses to statements rated on a scale with 1 being "not at all" and the highest rating being "very much." Except for the ease-of-use item and all items on the information quality index (measured on a 10-point scale), statements were rated on a 7-point scale. Indices were created by averaging each participant's responses to statements within the index. All indices were reliable at an alpha level of at least .60. The statements associated with each of the items and the indices as well as the alpha levels for each index are provided in figure 1.

Results

The data were analyzed using SPSS version 7.5 for Windows. Two-way analyses of variance (ANOVAs) were used to test for overall differences in responses to the manipulations. Three-way ANOVAs were then used to test for the moderating effects of culture.

Participants were 55 graduate students in engineering with a mean age of 26.7 years old. Twenty-five (45%) of the participants were Asian, twenty –two of whom were raised in Asia. The remaining participants were Caucasian (27), Black (1), and Hispanic (2) and raised in Europe or the Americas.

Participants completed the task in an average of 9.55 (SD=5.27) minutes with the fastest participant taking 1 minute and the slowest taking 32 minutes. Sixty percent of the participants performed the task accurately whereas 40% made some error in calculating the risk assessment value. On the dependent variables of interest, participants on average indicated moderate levels of control (M=3.75, SD=1.51), relatively high levels of self-efficacy (M=5.32, SD=.75) and relatively low levels of failure anxiety (M=3.05, SD=1.19). Ratings of the program for overall ease-of-use were relatively high (M=7.31, SD=2.54) as were perceptions of information quality (M=6.19, SD=1.75) and confidence (M=5.0, SD=1.67).

Effect of Choice and Domain Information

To test the first three hypotheses, an ANOVA analysis was performed with choice and information as dimensions predicting perceived control. As can be seen from table 1, the results do not support any of the first three hypotheses. Perceptions of control were not affected by increases in either choice or information provided in the interface. But, an examination of user's ratings of ease-of-use, information quality, and confidence suggest

that choice in an interface may have some effect on user perceptions. The results suggest a mixed effect. On one hand, choice increases user's confidence in the quality of the information provided by the interface (M=6.56 vs. 5.81) and in the value they generated (M=5.74 vs. 4.26). On the other hand, choice decreased perceived ease-of-use (M=6.54 vs. 8.11). There is also a marginally significant interaction effect between choice and information when predicting ease-of-use (F[1, 51]=3.24, p<.01) suggesting that choice decreased perceived ease of use, especially in situations of low information. These results suggest that although people appear to trust the information generated by an interface when more choice is provided, they find interfaces with more choice to be more difficult to use, particularly in the absence of relevant domain information. Although hypothesis three is not supported by these data, there is some suggestion that the availability of information makes choice more palatable.

Table 1: ANOVA results of choice and information predicting perceptions of control and ease-of use (N=55).

Independent Variables	Dependent Variables					
	Control	Self-efficacy	Failure Anxiety	Ease-of-Use	Confidence	Information Quality
Choice	.12	.45	.03	6.05 *	13.00**	2.79 a
Information	.90	.02	.40	<.01	.92	2.30
Choice * Information	<.01	.10	.14	3.24 a	2.13	.16

[a] p <.10. * p < .05. ** p < .01

Effect of Cultural Background

To test hypotheses 5 and 6, the relationship between choice, information, and culture was explored. Table 2 provides the mean response for the dependent variables by choice, information, and culture and table 3 provides the results of a 3-way ANOVA that was performed with choice, information, and culture predicting control. The results of these analyses suggest that culture may have a moderating effect on peoples' response to information and choice in an interface. As predicted by hypothesis 5, Asians reported feeling less in control when they had more choice (M=3.81 vs. 2.46) whereas Westerners reported feeling more in control when they had more choice (M=3.83 vs. 5.00). Although not significant, the results also suggest that increased choice results in a slight decrease in Asians' self-efficacy (M=5.49 vs. 5.54) but increases Westerners' sense of self-efficacy (M=5.31 vs. 4.98). These results provide support for hypothesis 1, but only for people from a Western culture.

Although not significant, the results also suggest a possible interaction between domain information and culture when predicting perceived control (F[1,47]=2.82, p<.10). Asians' reported higher levels of control when provided with domain information (M=4.92 vs. 3.92) whereas the Westerners' in this sample were somewhat indifferent to the

availability of domain information (M=3.27 vs. 3.10). These results suggest that hypothesis 2 only obtains for users from Asian cultures.

Further analyses show that Asians' reports of ease-of-use were indifferent to choice (M=8.38 vs. 8.08) while Westerners thought that more choice reduced ease-of-use (M=7.86 vs. 5.38). In addition, when taking culture into account, the main effect for ease-of-use ($F[1, 47]=5.34$, $p<.05$) and the interaction between information and ease-of-use ($F[1,47]=3.57$, $p<.10$) became marginally significant suggesting that, controlling for culture, choice only contributes to perceived ease-of-use if people have domain information to support their choices. This result provides tentative support for hypothesis 3 that argued that information must be available for choice to have a positive effect.

Effect on Performance

An examination of performance shows that making choices and processing information requires more time. Users in the low choice condition took 6.8 (SD=3.16) minutes on average whereas users in the high choice condition took 12.18 (SD=5.60) minutes on average to complete the task. This was expected because the high choice condition allowed users much more freedom to explore the interface and to make "false starts" than did the low choice condition. Similarly, users in the low information condition took 8.06 (SD=4.18) minutes on average whereas users in the high information condition took 11.00 (SD=5.86) minutes on average to complete the task. This was expected because the domain information was provided as text and required additional reading time. High levels of choice also contributed to more errors. Users in the low choice conditions got the correct answer 85% of the time whereas users in the high choice conditions got the correct answer only 36% of the time.

Discussion

When examined as a two-way ANOVA, there was little support for the arguing that increased choice and domain information in an interface would increase perceptions of control. But, further analysis of the moderating effect of culture suggests some support for hypotheses 1 and 2 and strong support for hypothesis 5. Figure 4 illustrates the significant relationships by culture. The data suggest that culture moderates the relationship between choice and perceived control. Although Westerners experience a stronger sense of control when provided choice, Asians experience reduced control and reduced feelings of self-efficacy when provided with more choice in an interface. These results are consistent with recent research suggesting that increased choice is valued by Westerners because it allows them to assert their individualism and not valued by Asians because it makes it more difficult to identify and conform to the norms of their peer group.

Table 2: Mean responses (standard deviations) to information and choice manipulations by culture.

	Choice		Information	
	Low	High	Low	High
Control				
Asian	5.00 (1.08)	3.83 (1.83)	3.92 (1.43)	4.92 (1.59)
Western	2.46 (.97)	3.81 (1.06)	3.27 (1.32)	3.10 (1.14)
Self-efficacy				
Asian	5.54 (.68)	5.49 (.88)	5.68 (.48)	5.36 (.95)
Western	4.98 (.75)	5.31 (.65)	5.06 (.69)	5.26 (.73)
Failure Anxiety				
Asian	3.08 (1.61)	3.02 (1.15)	3.05 (1.32)	3.05 (1.49)
Western	3.07 (1.15)	3.04 (.95)	3.24 (.80)	2.87 (1.22)
Ease-of-Use				
Asian	8.38 (1.80)	8.08 (1.50)	8.42 (1.68)	8.08 (1.66)
Western	7.86 (2.54)	5.38 (2.76)	6.33 (2.90)	6.73 (2.99)
Information Quality				
Asian	6.13 (1.90)	6.69 (1.25)	6.12 (1.72)	6.65 (1.54)
Western	5.50 (1.79)	6.47 (1.87)	5.62 (2.18)	6.42 (1.86)
Confidence				
Asian	3.77 (2.05)	5.67 (.98)	5.33 (1.67)	4.08 (1.89)
Western	4.71(1.73)	5.80 (.94)	5.13 (1.60)	5.43 (1.34)

Table 3: Regression analysis of choice, information, and culture predicting control and ease-of-use variables (N=55).

Independent Variables	Dependent Variables					
	Control	Self-efficacy	Failure Anxiety	Ease-of-Use	Confidence	Information Quality
Choice	.09	.42	.03	5.34 *	13.75**	2.61
Information	1.58	.09	.27	<.01	1.07	1.98
Information * Choice	.06	.09	.21	3.57 a	2.29	.15
Culture	14.43 **	3.37 a	<.01	7.71 **	1.64	.73
Choice * Culture	13.96 **	.98	<.01	2.99 a	.82	.16
Information *Culture	2.83 a	1.60	.30	.26	3.53 a	.08
Choice * Information* Culture	1.72	<.01	.61	<.01	1.96	.02

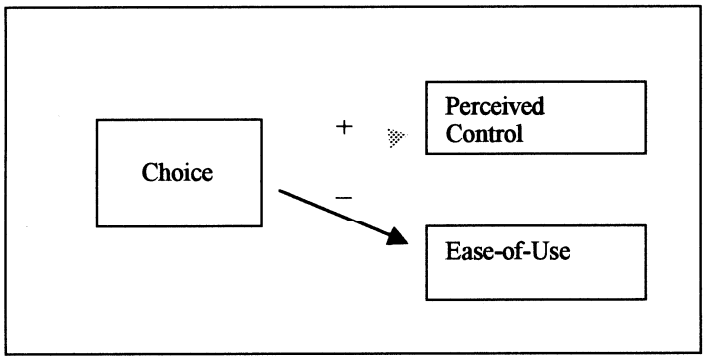
[a] $p < .10$. * $p < .05$. ** $p < .01$

The results also provide mixed support for hypothesis 2, suggesting that relevant domain information contributes to Asians' sense of control, but not to Westerners' sense of control. Although this effect was not hypothesized, it may be explained based on the importance of information for determining the likely behavior of others. Still, more research is needed to understand what is producing this cultural difference in response to information.

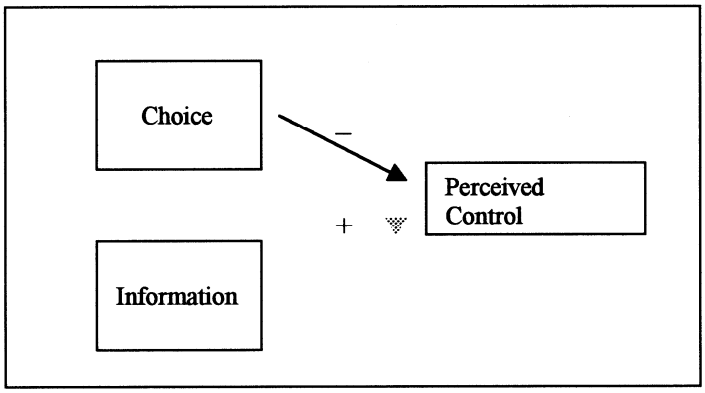
When controlling for culture, there was some evidence of an interaction between choice, information, and ease-of-use, suggesting that choice and information can act together to increase perceived ease-of-use for novice users. This result provides some support for the idea that choice is only valuable to the extent that users have adequate knowledge to make informed choices.

Figure 4: Illustration of significant relationships by culture in study 1.

Westerners



Asians



Study 2

Method

The goal of Study 2 was to examine the relationship between source credibility, orientation, and perceived control. Hypothesis 4 suggests that both expressed credibility and user orientation are required to increase users' sense of control. The study was a 2 x 2 between subjects design with credibility (low, high) and orientation (computer, user) as dimensions. Participants were asked to perform the same task as in study 1 using the Heartech system. All conditions in study 2 used the high choice/high information system from study 1 as a baseline system.

Participants.

Participants were 60 male graduate and advanced undergraduate (e.g. juniors and seniors) students enrolled in technical disciplines (e.g. engineering, computer science, physics) at Stanford University. They were recruited through postings on physical and electronic bulletin boards and were paid $20 for their participation.

Credibility Manipulation

Credibility was manipulated within the Heartech system. In the high credibility condition, participants were presented with a screen that read:

> *The Heartech risk assessment algorithm is based on information from the Heart Association and findings from recent research examining the causes of congestive heart failure. In previous tests, Heartech has been found to be extremely reliable and acdurate in producing congestive heart failure assessments based on this algorithm.*

Appendix C provides an illustration of the credibility screen provided in study 2. The credibility screen was presented after the initial general information screen. Participants in the low competence condition were presented with no additional screen.

Orientation Manipulation

Orientation also was manipulated within the Heartech system. Participants in the computer orientation condition were presented with a screen stating the goals of the system (e.g. accuracy, speed, etc.). Participants in the user orientation condition were presented with a screen on which they were asked to rate their priorities regarding the task. Once they rated their priorities, they were presented with a screen summarizing their priorities and indicating Heartech's intention of working with the user to achieve these goals. Appendix D provides illustrations of the Heartech computer orientation and user orientation screens.

Procedure

Study 2 followed the same procedure as Study 1.

Dependent Measures

Dependent measures were constructed in the same way as in Study 1.

Results

The data were analyzed using SPSS version 7.5 for Windows. Two-way analyses of variance (ANOVAs) were used to test for overall differences in responses to the manipulations. Three-way ANOVAs were then used to test for the moderating effects of culture.

Participants were 60 graduate students in engineering with a mean age of 23.5 years. Twenty-eight (47%) of the participants were Asian, ten of whom were raised in Asia. The remaining participants were Caucasian (28) and Hispanic (3) and raised in Europe or the Americas.

Participants completed the task in an average of 12.27 (SD=3.13) minutes with the fastest participant taking 6 minutes and the slowest taking 20 minutes. Sixty-nine percent of the participants performed the task accurately whereas 31% made some error in calculating the risk assessment value. On the dependent variables of interest, participants on average indicated moderate levels of control (M=3.53, SD=1.48), relatively high levels of self-efficacy (M=5.20, SD=.91) and moderate levels of failure anxiety (M=3.85, SD=.99). Ratings of the program for overall ease-of-use were relatively high (M=6.24, SD=2.43) as was confidence (M=5.1, SD=1.57). Perceptions of information quality were moderate (M=5.07, SD=1.57). Overall, ratings were similar to those in study 1 although average ratings for ease-of-use and information quality were higher in study 1 than in study 2.

To test hypothesis four, a two-way ANOVA was performed with credibility and orientation predicting perceived control. As can be seen from the results presented in table 4, credibility increases perceived control ($F[1, 55]=4.50$, $p<.05$) but a user versus a computer orientation has no significant effect on perceptions of control ($F[1, 55]=1.75$, n.s.). The data suggest that increasing the credibility of an interface increases peoples' sense of control (M=3.90 vs. 3.14) and feelings of self-efficacy (M=5.45 vs. 4.94). But users' anxiety about failing also increased when the interface was established as more credible (M=4.27 vs. 3.42). This may suggest that users took the task more seriously when they perceived the interface as credible. Although having a user orientation did not effect user's sense of control, it did contribute to more positive perceptions of ease-of-use (M=6.63 vs. 5.83). Contrary to hypothesis four, these results suggest that credibility can act independently from user orientation to effect users' perceptions of control.

Table 4: ANOVA results credibility and user orientation predicting perceptions of control and ease-of use (N=59).

Independent Variables	Dependent Variables					
	Control	Self-efficacy	Failure Anxiety	Ease-of-Use	Confidence	Information Quality
Credibility	4.50 *	4.99 *	13.12 **	.16	1.50	1.35
User Orientation	1.75	.30	.65	4.62	1.48	.89
Credibility * User Orientation	.63	.67	.59	.33	.46	<.01

[a] $p < .10$. * $p < .05$. ** $p < .01$

To test hypothesis 5, the relationship between credibility, orientation, and culture was explored. Table 5 provides the mean response for the dependent variables by credibility, orientation, and culture and table 6 provides the results of a 3-way ANOVA was performed with credibility, orientation, and culture predicting control. The results of these analyses suggest that credibility and orientation are robust across cultures. In these models, credibility continues to contribute to a sense of control and self-efficacy, and increase failure anxiety in both Asian and Western cultures. Although not significant, there is some evidence that a user orientation increases feelings of control among Asian users (M=3.96 vs. 3.70) while it decreases feelings of control among Western users (M=2.79 vs. 3.82).

An examination of performance suggests that neither users' accuracy nor users' time to complete the task were effected by the credibility or orientation manipulations.

Discussion

The results from study 2 suggest that source credibility increases users' sense of control and self-efficacy. But, source credibility also increases anxiety about failing. Source credibility shifts the burden of errors to the user because it establishes the interface as accurate and trustworthy. Thus, the user may feel more accountable for errors and therefore, more fearful about failing the task. Such a response is consistent with research on social loafing showing that people are more concerned about task performance when their contribution can be detected and when the standard for performance is high (Harkins, 1987). The main effects for source credibility were robust across cultures, suggesting that source credibility is a more universal determinant of perceived control than information or choice.

The absence of a relationship between orientation and control also obtained across cultures. Contrary to predictions, there was some evidence that Westerners prefer a

computer orientation (M=3.82, SD=1.59) to a user orientation (M=2.79, SD=1.43; t[59]=23.31, p <.01). The design of the experimental interface required that subjects in the user orientation condition establish priorities against which the interface was to operate. As novices, users may have felt that they did not have enough knowledge to choose the priorities wisely. Being asked to set priorities without adequate information may have contributed to subjects reduced sense of control.

Table 5: Mean responses (standard deviations) to credibility and orientation manipulations by culture.

	Credibility		Orientation	
	Low	High	Computer	User
Control				
Asian	3.08 (1.15)	4.47 (1.16)	3.70 (1.26)	3.96 (1.45)
Western	3.19 (1.65)	3.33 (1.52)	3.82 (1.59)	2.79 (1.43)
Self-efficacy				
Asian	5.09 (.56)	5.40 (.74)	5.23 (.54)	5.28 (.81)
Western	4.81 (1.16)	5.50 (.92)	5.26 (1.28)	5.05 (.94)
Failure Anxiety				
Asian	3.62 (.89)	4.12 (.79)	4.04 (.64)	3.71 (1.06)
Western	3.26 (.88)	4.41 (1.02)	3.80 (1.06)	3.83 (1.16)
Ease-of-Use				
Asian	6.46 (2.14)	6.60 (2.16)	5.87 (2.17)	7.31 (1.84)
Western	5.87 (2.89)	6.07 (2.55)	5.79 (3.02)	6.12 (2.47)
Information Quality				
Asian	6.65 (1.67)	7.05 (2.04)	6.68 (1.92)	7.08 (1.83)
Western	6.30 (1.68)	6.88 (1.68)	7.18 (1.66)	6.09 (1.51)
Confidence				
Asian	5.38 (1.50)	5.67 (.90)	5.67 (.82)	5.38 (1.56)
Western	4.37 (1.82)	4.93 (1.71)	4.93 (1.98)	4.41 (1.58)

Table 6: Regression analysis of credibility, orientation and culture predicting control and ease-of-use variables (N=59).

Independent Variables	Dependent Variables					
	Control	Self-efficacy	Failure Anxiety	Ease-of-Use	Confidence	Information Quality
Credibility	4.91 *	4.96 *	11.42 **	.01	1.87	1.77
Orientation	1.11	.32	.63	2.03	1.55	.87
Credibility * Orientation	.58	.56	.39	.27	.33	<.01
Culture	1.66	.09	.03	1.13	3.87 a	.16
Credibility * Culture	2.28	.65	1.70	<.01	.27	.13
Orientation * Culture	3.44 a	.41	.31	.72	.15	2.86 a
Credibility * Orientation * Culture	.37	.81	2.52	1.48	5.47 *	2.02

[a] $p < .10$. * $p < .05$. ** $p < .01$

General Discussion

The studies reported here provide some support for each side in the raging debate about how to provide users' a sense of control. In support of the "direct manipulation" view, the results indicate that choice is important to users in Western cultures. Choice can contribute to users' sense of control, but increasing the amount of choice in interfaces is not the panacea. Choice decreases users' sense of control in Asian cultures and reduces perceived ease-of-use for users from all cultures. In support of the "agent" view, the results indicate that novices prefer to delegate to a credible source. Novices prefer an interface to act as an agent and establish task priorities, particularly when the agent has established itself as credible in the task domain.

Control in human-human interaction is a complex phenomenon. The research reported here confirms that this complexity also obtains in human-computer interaction. The extent to which a user feels "in control" when using an interface depends on a variety of factors including characteristics of the task, the context in which the task is being performed, and the individual. Still, the results from these studies point to several design opportunities that may be applicable across many tasks and individuals. For example, increasing source credibility, domain information, and computer orientation should generally have a positive effect across novice users. Although neither domain information nor computer orientation contributed to an increased sense of control across cultures, neither Westerners nor Asians were negatively effected by either of these manipulations. Therefore, the overall result (across cultures) should be positive.

Design suggestions with regard to choice are more difficult. Others have argued that Asians are negatively disposed toward choice because they do not want to differentiate themselves from their peers whereas Westerners prefer choice as a way of expressing their individuality (Sethi & Lepper, 1998). To meet the needs of Asian audiences, interfaces should allow users to determine the patterns of behaviors of similar others. One established way of doing this is with default options. With default options, especially if linked to the appropriate reference group, Asians would be able to achieve their goal of making choices that are consistent with those of their peer group. But, default options also leave plenty of choices for Westerners for whom choice is a vital determinant of perceived control.

These studies have several limitations. First, both studies were designed for novice users. Subjects in the study had no domain knowledge (congestive heart failure) and no previous experience with the interface, although all had extensive experience with computer interfaces. Still, novice users may not respond the same way as would expert users to increased choice, domain information, a credible source, or a computer orientation. On the choice dimension, I would predict that people with expertise would value choice more than novices. At least for Westerners, this would increase the positive effect of choice. Also, source credibility may be less important when users have adequate knowledge to evaluate the performance of the interface. Additional research with more experienced users and with different tasks is needed to determine the generalizeability of the results to other populations.

Another limitation of these studies is that the constructs of choice, information, credibility, and orientation all were manipulated by representing them within an interface. Clearly, these constructs could have been represented in almost an infinite number of ways. Therefore, further research should provide alternative ways to manipulate these constructs. For example, in study 2, the user orientation manipulation required that users make choices about the priorities for the task. User orientation could also be manipulated without user involvement. This would put less pressure on novice users and may result in higher levels of perceived control than detected in study 2.

The results of study 1 show a negative relationship between choice and ease-of-use across cultures. At the onset of this research, I expected a strong positive relationship between perceived control and ease-of-use, but a negative relationship suggests that perceived control and ease-of-use are orthogonal constructs. Therefore, designers may need to make trade-offs between providing a sense of control and providing interfaces that are perceived as easy to use. Such tradeoffs will need to consider the users and task characteristics. Because ease-of-use was not the primary focus of these studies, perceived ease-of-use was measured by a single question. Future research exploring the relationship between perceived control and ease-of-use would benefit from using one of the ease-of-use scales provided by other HCI researchers.

In the studies reported here, culture was determined by ethnic background. Subjects were classified as Asians if they reported Asian ethnicity and as Westerners if they reported

Caucasian, Black, or Hispanic ethnicity. It is possible that the sample of Asians, especially in study 2 where 64% of the Asians in the sample were raised in Western countries, was highly influenced by the Western cultures in which they were raised. But, a sample of people raised in Asia should have shown even stronger cultural effects than the ones shown here. In their research on cultural differences in values for choice, Sethi and Lepper's sample (1998) was Asian American's and they reported the same effect found here. When examining ethnicity and the country in which subjects were raised, the same pattern of effects hold. That is, ethnicity as opposed to country of origin or facility with the English language[1] appears to be generating the effect. Future research is needed that examines more directly the relationship between interface design characteristics, control, cultural background, and country of origin. Work is needed that both attempts to replicate the results found in this study and further explores the mechanisms generating the differences.

Much of the theoretical and conceptual foundation for these studies has been borrowed from research in social psychology. Although not all of the findings from social psychology were replicated in these experiments, this work reinforces the value of using social psychology to inform and to guide HCI research. In particular, social psychology can help us to predict how peoples' social responses (i.e. perceived external control) will be effected by the design of technology. Nass and his colleagues (for example, see Reeves & Nass, 1996) argue that people respond socially to computers. The work reported here confirms a distinctly social response, but also highlights the importance of testing these concepts in an HCI context to determine which phenomenon are transferable and which are not. It also highlights the importance of looking at the cultural differences in social responses and avoiding the trap of applying research conducted on a largely Western population to products with intended audiences around the globe.

[1] Language skills were not measured in these studies, but observation suggests that most of the subjects who were raised in the West were more fluent in English than who reported being raised in Asia. An examination of time to complete the tasks shows no significant difference in time to complete the task between Asians raised in the Asia and those raised in the West.

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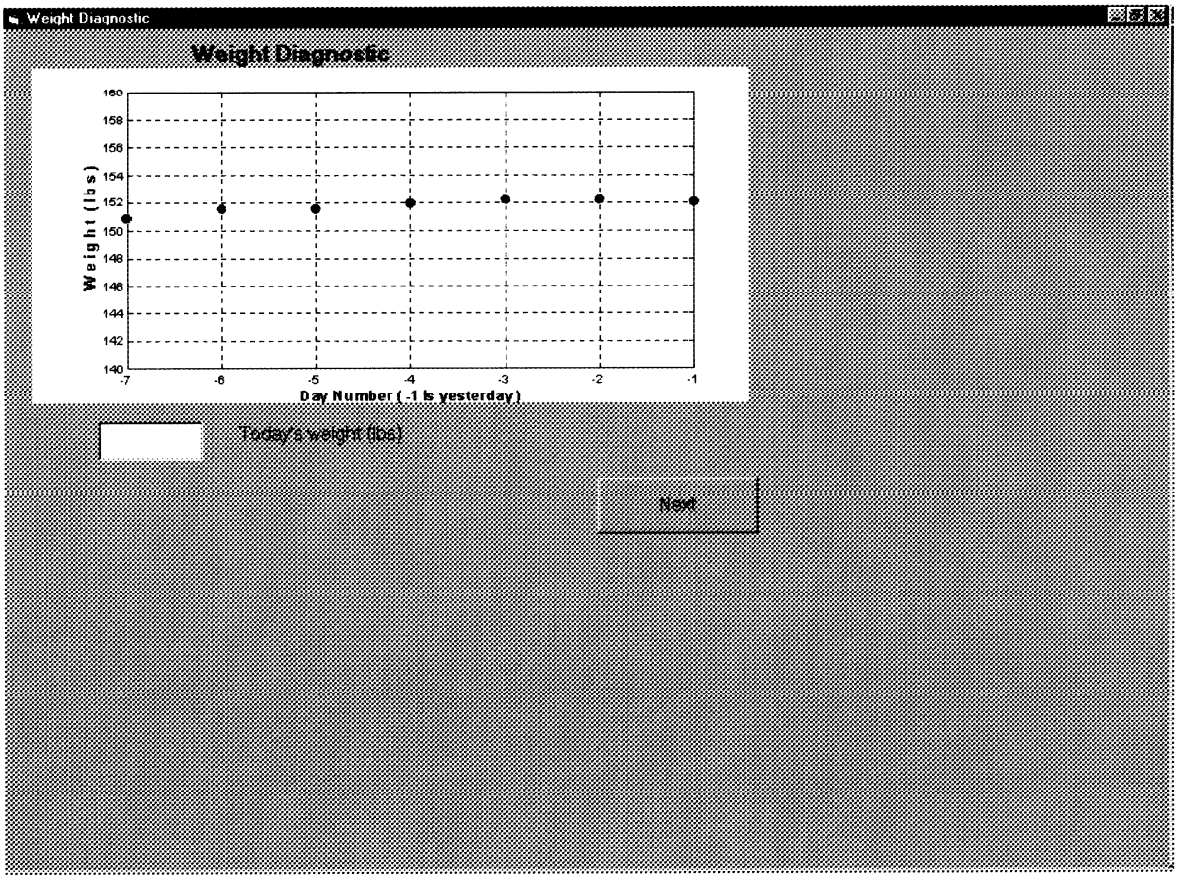
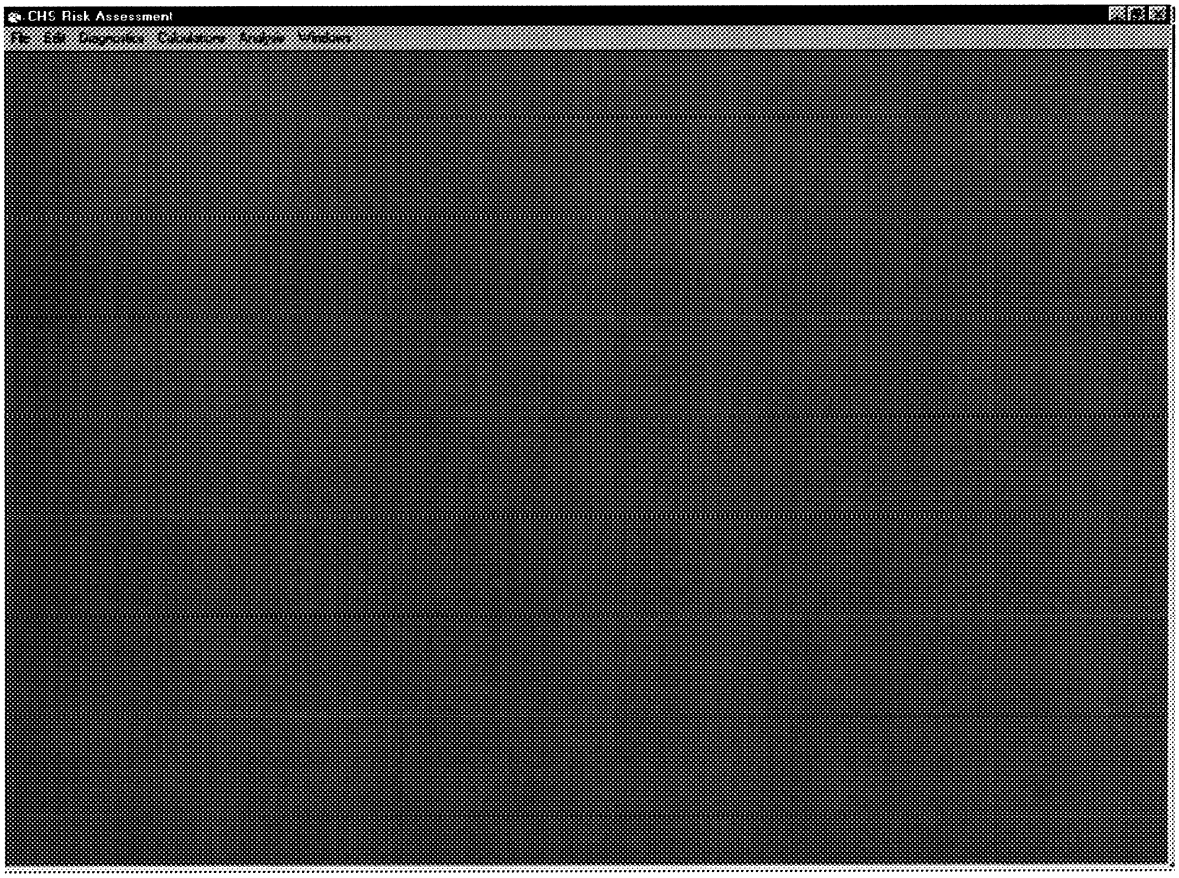
Appendix A: Illustration of Heartech screens for low and high choice conditions in study 1.

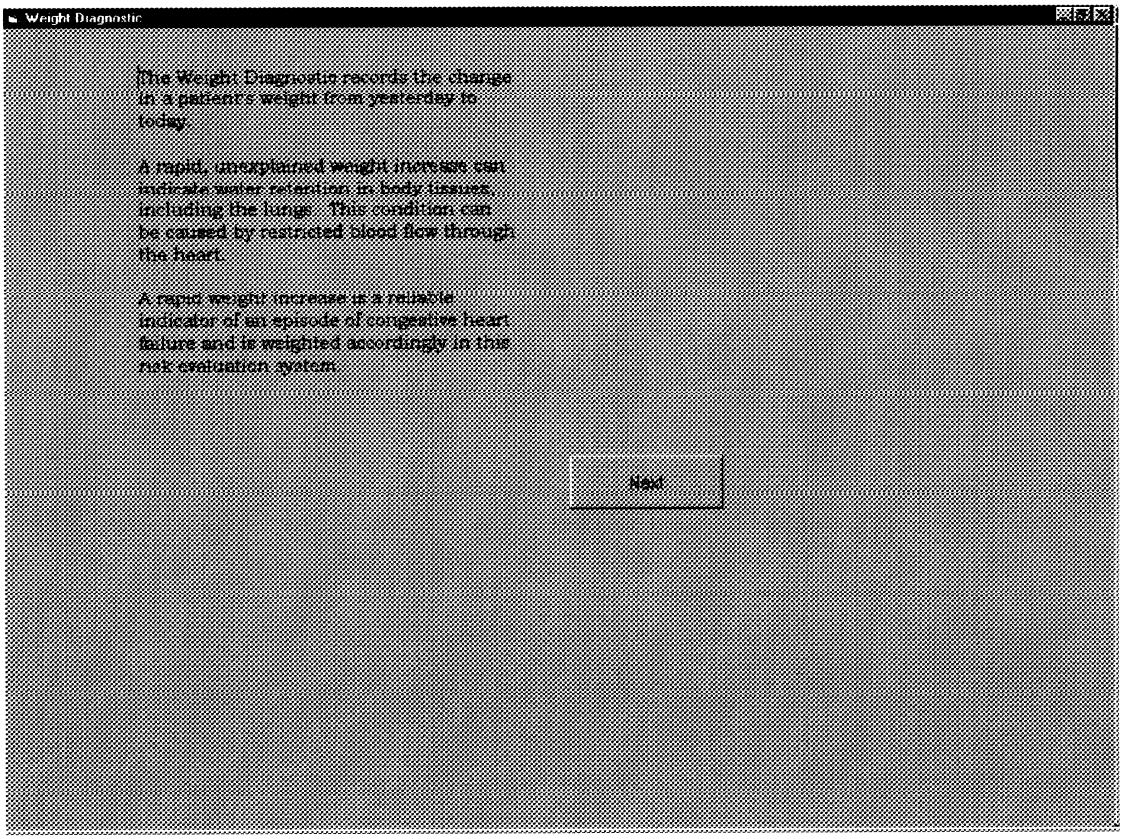


Low Choice

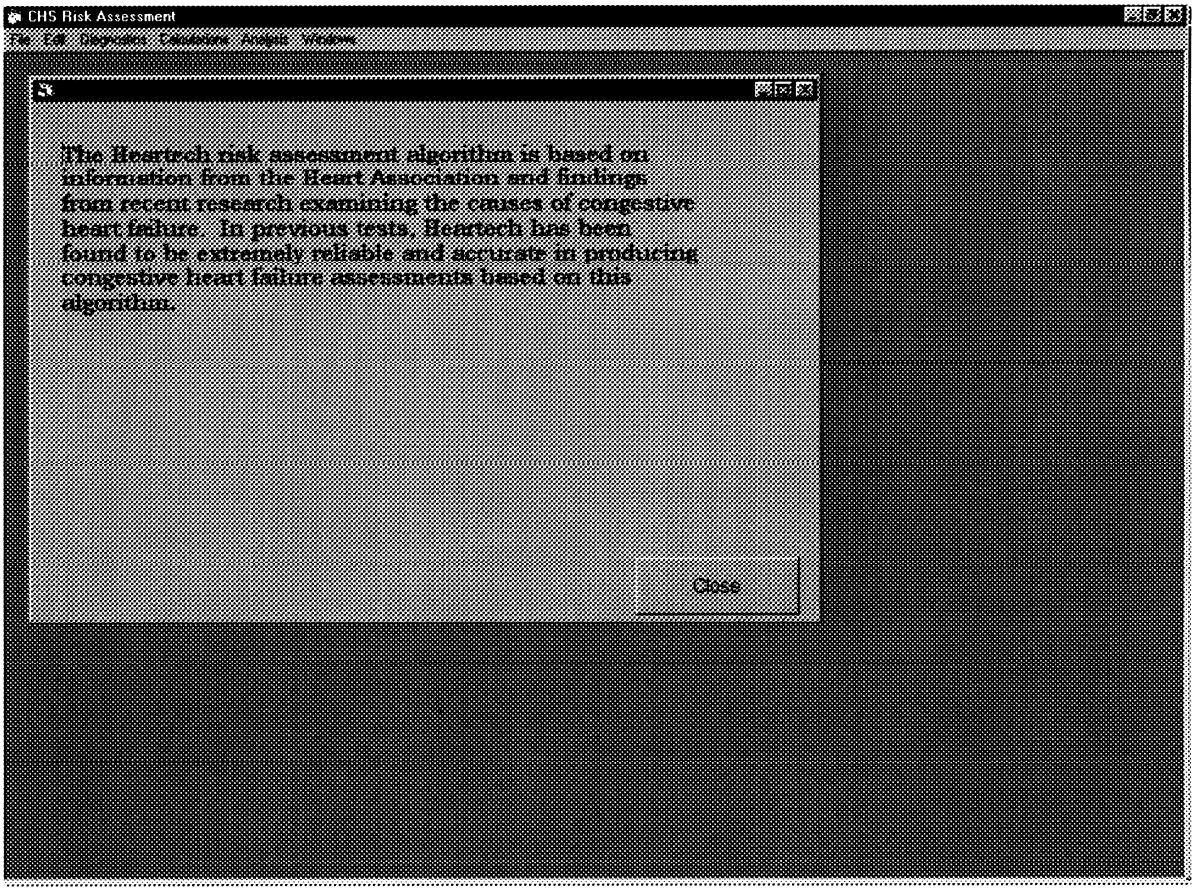


High choice

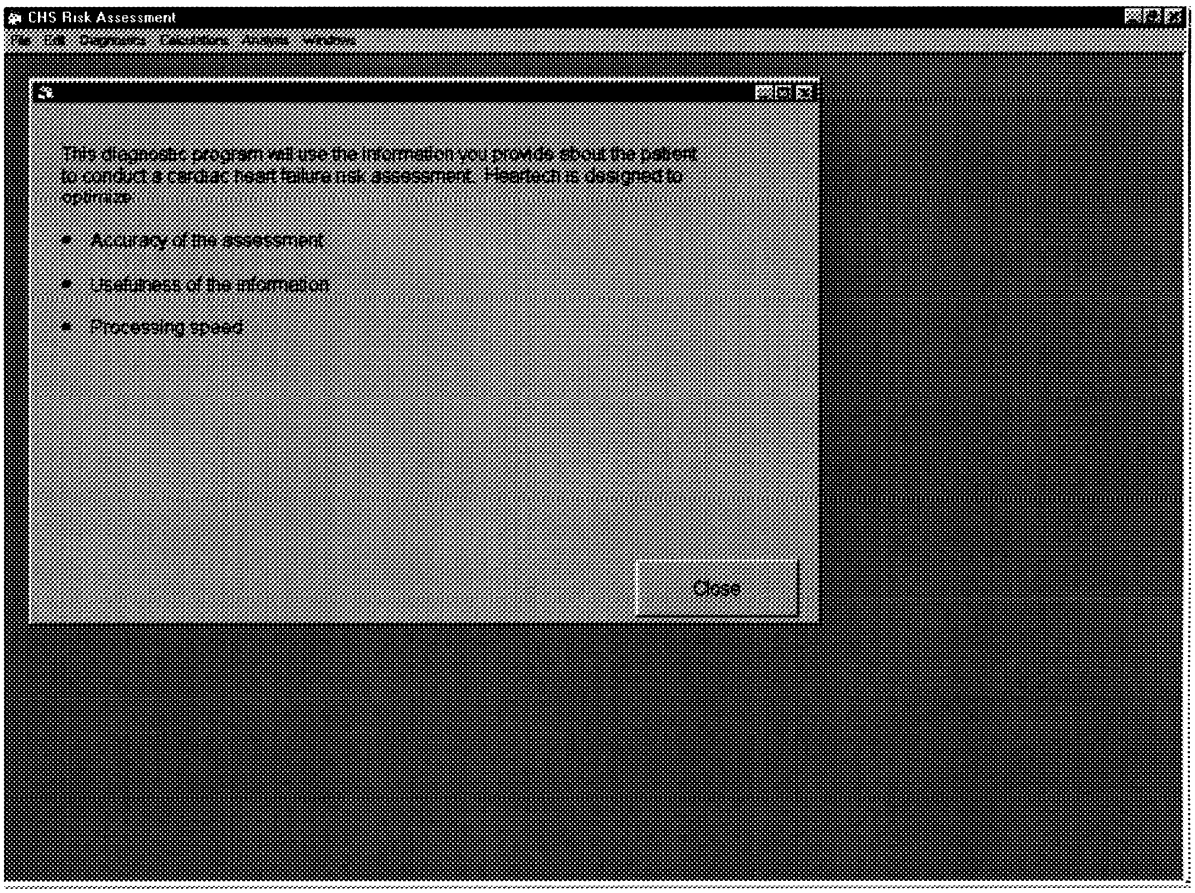
Appendix B: Illustration of a Heartech screen in the high information condition (low choice) in study 1.



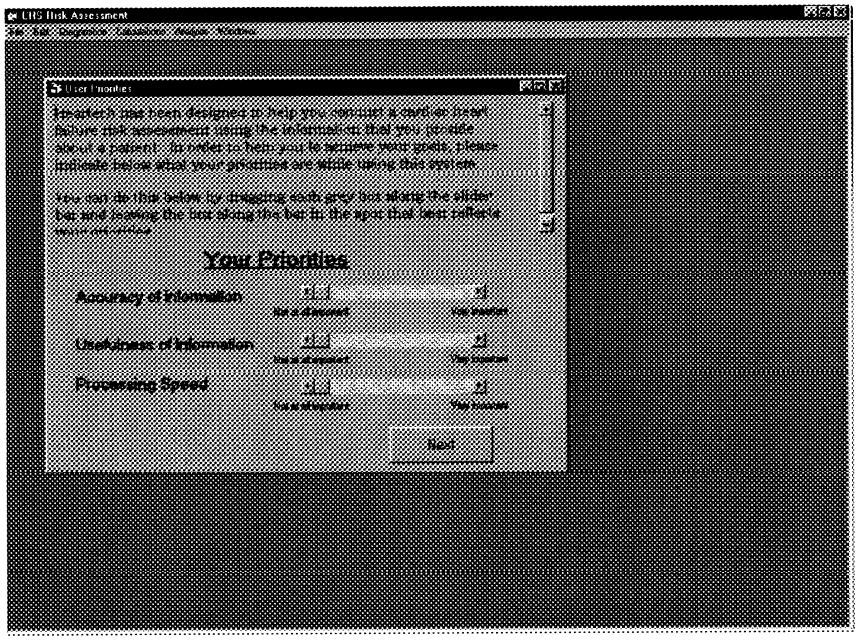
Appendix C: Illustration of Heartech screen for high credibility conditions (study 2).

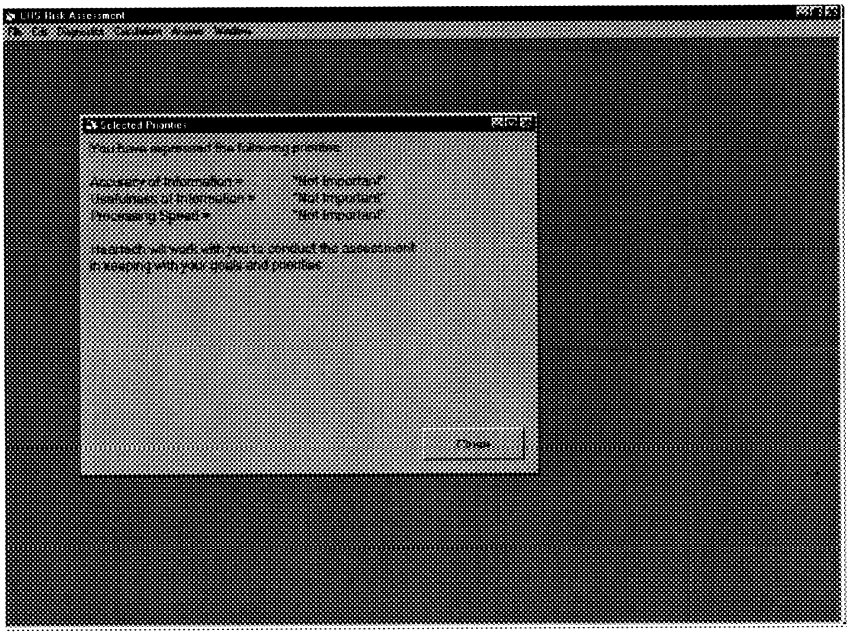


Appendix D: Illustrations of Heartech computer orientation and user orientation screens (study 2).



Computer Orientation Screen





User Orientation Screens