Modeling cyclic interaction: an account of feedback

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ABSTRACT
This paper reports an empirical study of the effectiveness of different kinds of feedback to signal that a goal has been successfully completed. Participants had to make setting changes to a simulated cell phone while at the same time dealing with incoming messages. One group had only implicit feedback that the setting had been changed so that success had to be inferred from the lack of an error message. The other groups had explicit feedback for a set period of 1, 2 or 5 seconds. The implicit feedback group were significantly less likely to complete the task than the explicit feedback groups. There is also evidence that the one second timed explicit feedback condition was less effective in inducing participants to eliminate their current subgoal than the two and five second explicit feedback conditions. A notation is introduced to explain these findings.

Keywords
Cyclic interaction, feedback, goal elimination, interaction unit, interaction design, mobile devices, cell phones.

INTRODUCTION
Interactivity in any system comes from the feedback which removes any doubt about what the system is doing and how it is responding to the user's action. For example, where there is a long system delay a user needs feedback to know that the system is actually responding to their last action and how the command is progressing. Feedback is also needed for goal elimination, that is, to show that a command has been successfully completed. Consider the task of changing the settings on a mobile device such as a cell phone and a PDA. Having taken the actions necessary to make such a change users need feedback on the new state of the system so that they can eliminate this goal and go on to their next task. Poor feedback may not provide sufficient information to do this in which case they will be compelled to re-do the actions to check they were successful.

An analysis of cell phones currently on the market shows that the feedback given is very variable between and indeed within models. Four feedback types may be distinguished. In *implicit feedback* the new state of the system is not displayed. The display simply goes on to prompt for the next action and success in achieving the current goal has to be inferred from the lack of an error message. This is the kind of feedback found in the DOS environment, when a user types 'del my.doc' to delete a file, and, if correct, the system responds with a new command-line prompt without an error message. The user cannot see that the file is no longer in the directory without typing another command. With *timed explicit feedback* the new system state is displayed but only for a short period. The industry has adopted different standards for this period of time, e.g., some Nokia™ models use 2 secs, whilst some Ericsson™ phones use over 3 secs. With *manually cancelled explicit feedback* the new system state is displayed until the user acknowledges it by canceling the display. This is the principle behind an "alert" in graphical user interfaces. Finally, some cell phones use a hybrid, *manually cancelled explicit feedback with timeout*. This is the same as timed explicit feedback but pressing any key removes the display.

This paper reports findings of an experiment that compares implicit feedback (IF) and timed explicit feedback (EF) using a web simulation of a mobile device. Participants had to change three settings on this device while at the same time dealing with simulated messages. Their ability to complete the task, and the number of times they revisited one of the settings dialogues was compared.

METHOD
Ninety-two students at the University of York were recruited by email with the promise of being entered into a prize draw. Their task was to switch off three sound-related functions: keypad, ringing, and message alerting sounds.

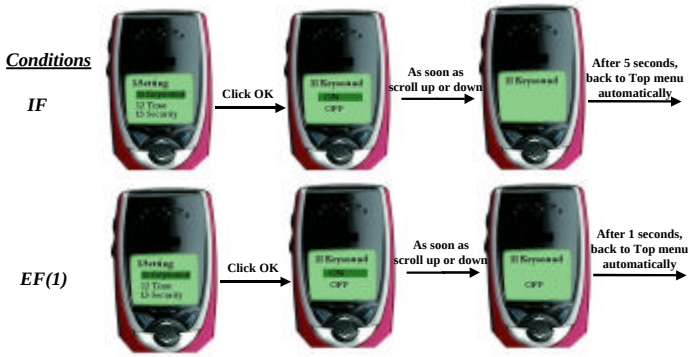

Figure 1. Experimental conditions: IF, EF(1). The other EF(2) and EF(5) are the same as EF(1) except for the duration of feedback.

Participants were randomly assigned to one of four experimental conditions (see Figure 1). In the *IF* condition there was no visual feedback that the participants had switched off the sound function on the display as they changed a setting. Success had to be inferred from the fact that the system has moved on to an appropriate new state (the top-level menu). In contrast, the *EF* conditions provided explicit feedback for either 1, 2 or 5 seconds. The task involved navigating a 3-level menu hierarchy and was

CHI 2003, April 5-10, 2003, Ft. Lauderdale, Florida, USA.
ACM 1-58113-454-1/03/0004.

made harder by interruptions from incoming messages that had to be dealt with immediately.

	N	*Success*	*Revisit*	*Mean number of type 1 revisit (S.D)*
IF	23	7	22	1.55 (.74)
EF(1)	23	16	15	1.33 (.72)
EF(2)	23	17	15	.80 (.17)
EF(5)	23	21	10	.58 (.51)

Table 1. *Success* is the number of participants out of *N* who successfully switched off all three sound functions. *Revisit* is the number out of *N* who returned to at least a sound function.

RESULTS

Table 1 gives the data. Chi-square tests demonstrated that explicit feedback resulted in more participants completing the task than implicit feedback. There was no significant difference between the EF conditions. *Revisit* tells a similar story. Participants in the IF condition were more likely to revisit the functions that they had already set to off. These results suggested the poor performance of the participants in the IF condition may be due to failures to eliminate their subgoals, so that they repeated tasks they had already performed. It is possible to distinguish between two types of *Revisit*. A participant could revisit a sound function immediately after setting it. This first class of revisits implies that a subgoal has not been eliminated due to poor feedback. Alternatively, the second class of revisits may occur after some other sound functions have been visited. This revisit, implying a failure of working memory, was uncommon. The *mean number type 1 revisits* was computed only for participants who made at least one type 1 revisit and is displayed in Table 1. Analysis of variance demonstrated that the means for IF and EF(1) are both significantly higher than the means for EF(3) and EF(5) (HSD = .314). This shows that the duration of explicit feedback can influence its effectiveness.

CONCLUSIONS AND DISCUSSION

These results suggest that explicit feedback is useful and can prevent users from unnecessarily revisiting tasks they have in fact completed. Further it would appear that, in this case, a minimum duration of two seconds is optimal. Further work is needed to contrast other feedback types such as manually cancelled explicit feedback, with and without timeout. Further work is also needed to check that this result generalizes to other contexts of use. However, it can be concluded that these are practically important issues that need to be tackled.

This experiment is part of a program of work to allow designers to reason about low level interaction design for novel devices. As part of this work we have developed the interaction unit (IU) notation with which a designer can reason about the effectiveness of a new interaction widget [1]. This follows the cyclic interaction approach [2] and can describe the goal-reorganization process in the experiment described above. Tables 1 and 2 are fragments from an IU analysis of these two interfaces. They make explicit the designer's assumptions implicit in these two feedback methods. That is, how the user generates and eliminates subgoals in the critical part of this task. The difference is that in the EF conditions the user can recognize that the subgoal can be eliminated whereas in the IF condition they have to recall that a certain action as been taken. A designer using the IU analysis is warned that this is a dangerous assumption to make. In this way the IU model is able to account for the intimate connection between goal, action and the environment, allowing designers to make explicit what a process achieves, as well as what triggers it.

REFERENCES

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Acknowledgements

The author acknowledges the help of his supervisor, Andrew Monk; also financial support from Daewoo.

	Environment		***User***			***Interaction***
	Most Recent Change	Other Information	Current Goal	Recognition/Recall/Affordance	Change to Current Goal	Action
			Set OFF Keysound.			
IU_1	[START *from* *MenuItem(ON)* Visible; *MenuItem(OFF)* Visible.]	-	Set OFF Keysound.	Recognize Highlighted *MenuItem(ON)*; Affordance Click *Button(∨) --> OFF* Highlight.	(+) Specify OFF.	Click *Button(∨).*
IU_2	*MenuItem(ON)* Disappear; *MenuItem(OFF)* Disappear. *when* Click *Button(∨).*	-	Specify OFF; Set OFF Keysound.	Recall Click Button(∨).	(-) Specify OFF; (-) Set OFF Keysound.	[END]

Table 2. A cyclic notation: the IU model for setting key-sound off in the IF condition

IU_1	As Table 2					
IU_2	*MenuItem(ON)* Disappear. *when* Click *Button(∨).*	*MenuItem (OFF).*	Specify OFF; Set OFF Keysound.	Recognize Keypad OFF.	(-) Specify OFF; (-) Set OFF Keysound.	[END]

Table 3. A cyclic notation: the IU model for setting key-sound off in the EF conditions