Proceedings of the Institute of Acoustics

THE EFFECTS OF WARNING FORMAT AND KEYBOARD LAYOUT ON REACTION TIMES TO AUDITORY WARNINGS.

MISS S H JAMES (1) AND MISS M R JAMES (2)

MISSION MANAGEMENT DEPARTMENT, HUMAN ENGINEERING DIVISION, NOISE AND VIBRATION SECTION, RAE FARNBOROUGH, HANTS.

SUMMARY

This report details the findings of a preliminary investigation into the effects of warning format on response times to auditory warnings. Three warning formats were used - voice messages only, voice messages preceeded by an alerting 1KHz tone and voice messages preceeded by a prioritised alerting signal (attenson). For each format subjects were required to respond by pressing the key that was correspondingly labelled. There were 9 voice messages and each was presented 5 times per session. Subjects attended seven sessions; one training and one for each warning format for two keyboard layouts. The keyboard layouts were Blocked (warnings grouped in their priorities) and Scrambled (warnings in a randomised layout).

The results showed that the subjects were able to respond significantly faster with the prioritised alerting signals than with the 1KHz tone which was in turn significantly faster than to the voice messages alone. Also, in all format conditions the Blocked keyboard enabled subjects to respond significantly faster than the Scrambled keyboard. These results provide design guidance for the introduction of auditory warning systems into high stress environments.

1 INTRODUCTION

1.1 Background

In modern military aircraft the warning systems which alert the pilot to problems rely mostly on visual signals in the form of warning lights on a central warning panel (CWP). However, with increasing operational workload and the use of night vision goggles, the chances of an illumination on the CWP passing unnoticed is increased. For those aircraft that do have audio warnings the sounds are generally too loud and strident and this can cause a number of problems; startle, interference with communications and a tendency to react by first operating the mute or cancel button, being a few. Such sounds may disrupt the pilot's thoughts and communications as well as inhibiting his reactions. The sounds are generally ill considered, rarely (if ever) designed as an integrated set and can even be counter-productive.

REACTION TIMES TO AUDITORY WARNINGS.

Such problems are avoidable and the Human Engineering Division of Mission Management Department at RAE Farnborough, in conjunction with the Institute of Sound and Vibration Research (ISVR) at Southampton University and the Medical Research Council's Applied Psychology Unit at Cambridge have developed a new system of audio warnings based on psychoacoustic and acoustics research.

These auditory warnings are sequences of attensons (attention getting sounds) coupled with associated voice messages. The attensons have been constructed from bursts of sounds with frequency components and noise envelopes designed to cut through the background noise so that they will always be detected when they are presented, with a minimum chance of undesired side-effects.

Some problems arising will require the pilot to take immediate action when the warning is presented, whilst for others he may have time before any action is necessary. Hence, in the design of the warning series the potential problems have been divided into four categories:

Priority one :- requiring immediate action.
Priority two :- requiring immediate awareness.
Priority three :- provides cautionary signal (awareness).
Priority four :- provides advisory information or status.

For each category an attenson was developed such that the perceived urgency related to the real urgency of the problem that had arisen. This was achieved by changing the constructional parameters of the attenson. A fifth attenson was designed for the category of low height. This warning system has been extensively tested in the MM4c Helicopter Noise Simulator at RAE and is under going flight trials in the RAE Seaking and Lynx helicopters.

MM4c is currently involved in collaborative auditory system research with the US Army at the NASA Ames Research Centre under the auspices of TTCP HTP-6. Collaborative work programmes have been drawn up to look at various aspects of auditory warning systems and their applications. However, some preliminary work is necessary to establish test techniques that provide consistent results between the two establishments. Hence, MM4c undertook to replicate some work previously carried out in the Crew Station Research and Development Facility (CSRDF) at NASA Ames which looked at the requirement for attensons in auditory warning signals. This report discusses the results achieved by both establishments, the conflicts in the interpretation of results and conclusions drawn.

2 RATIONALE AND DESIGN

2.1 Rationale

The preliminary research reported here was performed to assess the relative merits of auditory warning formats including non-specific attensons (eg.1KHz tone), prioritised attensons or simply a voice message alone and their subsequent effects on subject response time. Response times were used as a measure because they give an indication of how effective the warning formats are. When a problem arises a fast response is essential if the warning is of high priority, but accuracy of response is also important.

The U.K. philosophy on the inclusion of attensons in auditory warning signals stems from research into the use of prioritised attensons which differ from each other in their perceived urgency, reflecting the priority of the warnings with which they are associated. Prioritised attensons not only alert the pilot to the occurence of a problem but also provide him with information for the necessary action.

The US and UK differ in their approach to the inclusion of attensons. The US have primarily used a measure called 'System Response Time', which is the interval between the onset of the warning signal (in the case of a warning format with an attenson timed from the onset of the attenson) to the time when the listener has comprehended the message and decided on the first action. That research indicates that the attenson increases system response time excessively. However, the attenson used in the research was a 1KHz tone of 0.5s duration and therefore contained no additional information about the type of problem or the necessary action required. The RAE's philosophy is that by including information within the attenson the speed and accuracy of reaction to auditory warnings should improve.

2.2 Experimental design

2.2.1 Warning formats

The experimental design used in this study was developed from research carried out at NASA Ames. This preliminary work was performed in a low stress environment and in the quiet however, a more comprehensive study in which realistic stressors will be introduced (eg. high workload, communications, cockpit noise etc.) will follow.

The three warning formats investigated were:-

i No attenson condition- voice messages only
ii Non-specific attenson condition- a 0.75 second duration 1KHz alerting tone followed by voice messages and
iii Prioritised attenson condition- 3 different attensons that denoted the priority level of the warning (red, amber, green) followed by a voice message.

Time plots of these warning formats are shown in Figure 1. For experimental convenience, in order that the reaction times measured during the experimental sessions could easily be recorded by the computer, the three formats were stored in blocks of equal duration ie. the interval between the onset of the warning block and the end of the voice message was the same. For the voice-message-only condition the voice message was preceded by silence in order to maintain the same duration.

It was hypothesised that the slowest reaction times would be to the voice-message-only condition whilst for the non-specific attenson followed by a voice message the reaction times would be shorter as the subject would be primed and ready to respond. The prioritised attenson followed by a voice message would prime the subject and the information held in the attenson would reduce the number of response options. Hence, the prioritised attenson condition should produce the fastest reaction times.

2.2.2 Keyboard

The research was performed in the Mission Management Dept. Helicopter Noise Simulator and although the experiment was performed in a quiet environment the hardware and software used are as described in the reference.

The subject was required to sit in the simulator wearing a headset plugged into the communication system. A keyboard was positioned on the central panel to the left and in front of the subject The keyboard was arranged in a 4x4 matrix of non-latching, single press buttons (figure 2). The keys were connected to the computer so that the time and accuracy of response could be monitored.

The warning response buttons were in a 3x3 matrix and were labelled with the warning words of the voice messages e.g. servo, fire, electrics etc. The buttons were also illuminated and colour-coded, the colours being Red-Priority 1, Amber-Priority 2, and Green-Priority 3. Subjects were required to respond to the audio warning signals heard by pressing the correspondingly labelled key.

It was also anticipated that keyboard layout may have an effect on reaction times so two different formats were used:-

i Blocked keyboard : where the response buttons were aligned in their priorities (red-1, amber-2, green-3) down the 3x3 matrix.
ii Scrambled keyboard : where the response buttons were randomised within the 3x3 matrix.

Two buttons were dedicated to Yes/No responses which were used during training and in the introduction to each experimental session. Instructions were displayed on a computer monitor and the subject paged through them using the Yes and No keys. Three keys along the top row of the 4x4 matrix were labelled P1, P2, P3 and were used as response keys for training the subjects to recognise the prioritised attensons.

In previous, similar research subjects were provided with a 'HOLD' button that they kept depressed except when making responses. This method was adopted for this current research, the 'HOLD' button providing a control position for each subject's hand. This was necessary because the workload was low and simple reaction times may easily have been affected by hand position. The release of the 'HOLD' button could be monitored by the computer and hence also provided the exact time of first response to the warning message. A key from the main keyboard was extended back to a position near to the subject for this purpose as were the Yes and No keys, both for subject convenience.

The final button on the keyboard was labelled 'RT' (reaction time), and occupied the top left position on the keyboard. This button was used in conjunction with the 'HOLD' button to obtain a measure called 'Baseline Reaction Time' (BRT) and was primarily a physical measure of how long the subject took to move from the 'HOLD' key to the 'RT' key. This BRT measure was made before and after each experimental session and provided an indication of whether the subject had become fatigued during the experiment as well as giving some insight into the differences between subject's responding strategies.

3 EXPERIMENTAL PROCEDURE

3.1 Subjects

Twelve subjects were used in this study, 9 males and 3 females. Their ages ranged from 20 to 48 years and all were employed at the RAE. Although none were military aircrew a number were familiar with piloting aircraft or had a number of flying hours acting in the flight observer role in helicopters.

3.2 Training and Experimental sessions

Each of the three warning formats; No attenson (1), Non-specific attenson (2), and Prioritised attenson (3) was paired with the two keyboard formats; Blocked (B) and Scrambled (S). A repeated measures (3x2) design was used so all subjects attended all sessions. The conditions were balanced so subjects attended all the warning conditions for one keyboard format and then all the warning conditions for the other keyboard format. The presentation of warning formats themselves was randomised.

3.2.1 Training procedure

Initially, subjects attended a training session of approximately 30 minutes duration where they were introduced to the instrumentation and test procedures to be used in the experimental sessions. The subject was familiarised with the Baseline Reaction Time measure, each of the three warning formats, the nine associated voice messages and the three attensons. Half the subjects were trained on the blocked keyboard and half on the scrambled keyboard. The first three experimemtal sessions were always on the keyboard layout the subject had trained on. Subjects were given a few days rest between keyboard types to reduce confusion and carry-over effects.

3.2.2 Experimental session procedure

Subjects attended six experimental sessions. Each lasted approximately 25 minutes and was divided into three sections. Initially, BRT measurements were made. The subject sat with his finger on the 'HOLD' button and was presented with a 2KHz tone of 800ms duration over the headphones. On hearing the tone the subject had to move his finger as quickly as possible from the 'HOLD' key to press the 'RT' key. The time of release of the 'HOLD' key and the pressing of the 'RT' key were measured by the computer, the procedure was repeated a further nine times and an average of the ten BRTs was calculated.

The warning format and keyboard layout were then selected for test. The subject was asked to indicate when he was ready to hear a warning by pressing the YES key. In order that the subject was unable to anticipate the onset of the warning, the computer, on receiving the signal from the YES key presented a random delay of between 3 and 15 seconds before generating the warning format. NB. After the random delay there was an added short duration of silence due to inherent delay in the computer whilst it processed the warning format to be presented. This period was the same for all presentations and was less than one second duration. The computer then generated the appropriate warning format block and began the clock to measure the reaction time. For those warnings with attensons, the attenson was heard immediately but for the voice message only condition the subject continued to hear silence until the onset of the voice message, although the computer was actually clocking from the onset of the warning block (see diagramatic representation in Fig. 3).

The subject sat with his finger on the HOLD button and the warnings were presented over the headphones. He was instructed not to release the HOLD key before the onset of the voice message to ensure reaction times were recorded from the same hand position. Although this placed some restraints on the subject's response to the warning it was not until they had heard part of the voice message that they had enough information to make a correct response. The subject responded by pressing the correspondingly labelled key as quickly as possible.

Figure 3 shows the computer time sequence for the presentation of a warning format to a subject and his response to it. The reaction time was taken to be the interval between the onset of the voice message and the time the subject pressed the response key. This interval was chosen because, as mentioned previously, it was not until the voice message was heard that the subject knew exactly which key to press although for formats 2 and 3 he may have been primed with some idea of which colour key to press.

The nine messages were presented randomly a total of five times ie. 45 presentations were made and 45 reaction time measurements recorded by the computer.

It should be noted that for the warning format with prioritised attensons, before proceeding to the experimental session the subject was presented with a refresher course on the attenson types and their relative priorities. The subject was presented with each attenson and asked to respond by pressing either the P1, P2, or P3 key on the keyboard. If the subject's recall was less than 100% the procedure was repeated. When 100% recall was achieved subjects proceeded to the experimental session. All experimental sessions concluded with another BRT measurement.

4 RESULTS

4.1 General

For each experimental session attended, 45 response times were measured. For each subject and for each warning format on both keyboards, the mean reaction time was calculated (Table 1).

For both keyboard layouts the data shows distinct trends across the warning formats with the slowest times measured for the No attenson condition and the fastest for the Prioritised attenson condition. Generally, reaction times are faster with the Blocked keyboard layout than the Scrambled keyboard layout.

For the ten BRT measures made before and after each experimental session a mean value was calculated (Table 4) but no clear trends were apparent between the two sessions.

4.2 Statistical analysis

The experimental data and BRT data were analysed using paired t-tests and analysis of variance (ANOVA).

4.2.1. Experimental Data

Paired t-test results are shown in Table 2. Each warning format was compared against the other two for both keyboard layouts. Each warning format was then compared across keyboard layouts. All tests showed significant results ($p<0.001$) indicating that there were significant differences in response times between the warning format conditions and the keyboard types.

Both a two-way and three-way analysis of variance (ANOVA) was performed on the data (Table 3) in an attempt to look more closely at the source of the significant effects. The three-way ANOVA showed that not only was there a significant effect ($p<0.01$) of warning format, keyboard layout and subject but there were also significant interaction effects of all these.

4.2.2. Baseline Reaction Time Data

The BRT data collected for each subject was summed and means were calculated to give an overall BRT value for each subject for each BRT session ie. Before and After the experimental session (Table 4). All data points were compared for each subject using paired t-tests. These tests gave a range of results. Seven subjects showed significant differences between their Before and After BRT measures, however when a Before vs After t-test (summed for all subjects) was carried out the result was not significant (Table 4).

A two-way ANOVA was performed on the data between BRT session and subjects (Table 5). This showed that there was no significant effect of BRT session but there was a significant effect ($p<0.01$) due to subjects and an interaction between subjects and BRT session.

5 DISCUSSION AND CONCLUSIONS

5.1 Discussion

The results obtained for the experimental data were largely as predicted. The No attenson condition provided the slowest response times to the warnings, probably because there was no indication of when the voice message would arrive. This result also indicated that the delay introduced before voice message onset had its desired effect in making the onset unpredictable. The Non-specific attenson condition speeded up reaction times to the warnings significantly but the Prioritised attenson condition decreased reactions still further. We can assume from this that the additional information conveyed in the Prioritised attenson in some way reduced processing time, presumably by decreasing option choice.

The paired t-test results show that there is a significant effect of keyboard layout on reaction times with all warning formats. When the t-values are studied it appears that the keyboard layout has a more significant effect on reaction times when there is no attenson present and may suggest that if voice messages are used on their own it is more important to have a well designed keyboard display.

From the ANOVA results on the experimental data it appears that the effects shown on subject reaction time are not due to discrete experimental variables but some combination of them. In this research it was not essential to determine the exact cause of changes in reaction time but it was important to establish that the variables manipulated had an effect on them. A better understanding of the ways in which these factors contribute to subject response times is the aim of future research.

The analysis carried out on the Baseline Reaction Time data shows individual differences between subjects. Only five subjects show no significant difference in baseline response times measured before and after each experimental session, the others differ in significance levels from $p<0.05$ to $p<0.001$. It must be noted that these differences between BRT sessions are not all in the same direction, and when the results from the BRT sessions are studied as a whole, there is no apparent difference between them. In a study of this design it is likely that individual differences will be exaggerated because subject workload is low and reaction times are short. In future research, subject workload will be considerably higher and the subject's scenario will be more realistic and reaction times are likely to be more realistic, and will therefore be greater and more indicative of a working environment.

The results of an ANOVA on the BRT data confirm that there is no difference in reaction time between the BRT sessions. This result also lessens the likelihood of fatigue and boredom factors effecting the experimental data.

As mentioned previously similar work has been performed by the US army at the NASA AMES Research Centre, however, the UK and US differ in their definition of response times when an attenson is included. The RAE philosophy says that if a properly designed attenson precedes a voice message, it will cut through background noise and normal radio traffic such that a pilot engrossed in flying an aircraft under extreme conditions will detect it, allowing a more rational approach to the speed and accuracy of reaction.

During this current work the warning formats were built as described in section 2.2.1. such that when timed by the computer from their onset, all formats had the same duration. The reaction time was taken to be from the onset of the voice message (which was the same for all three formats, 1.5 seconds after the onset of the warning block) to the time of pressing the response button (the time sequences are shown in figure 4a) The results show that if an attenson is used, albeit a 1KHz tone or a prioritised attenson the reaction time is significantly faster than for the voice message only condition.

The US army compared only two warning formats, a voice message only and a voice message preceded by a 1KHz tone of 0.5 second duration. It should be noted that the work performed in the US was a more comprehensive study with realistic stressors such as high workload, communication and cockpit noise etc. and hence direct comparisons of response times may be difficult. However, a measure called 'System Response Time' (SRT) was used to assess the effectiveness of the warnings and was taken to be the interval from the onset of the warning format (for the voice message only condition from the onset of the voice message and for the attenson/voice message condition from the onset of the attenson) to the time the subject made his response.

Figure 4b compares the time sequences and shows that for the voice message only condition the SRT was shorter (5.14 seconds) than for the attenson/voice message condition (5.75 seconds). Had the RAE philosophy been adopted and the response timed from a common place in both formats eg. the onset of the voice message, the response time for the attenson/voice message would be faster at 4.75 seconds. The US acknowledge this fact but state that to attain this relatively faster reaction the attenson has to be provided in the first place, hence the use of SRT. If the SRT philosophy had been applied to the RAE work similarly, the voice message only condition would would produce faster response times.

A more comprehensive study, already started at RAE, will present subjects with the same three warning formats under more realistic flight conditions. It is hypothesised that voice message only warnings may be totally overlooked by the subject due to high workload and high levels of background noise whereas the warnings with the appropriately designed prioritised attensons will be detected 100% of the times they are presented and due to the extra information they carry will enhance the speed and accuracy of the subject's response.

5.2 Conclusions

The results of this preliminary study conclude that auditory warning formats are important in determining subject response times to warnings. By taking reaction times as an indication of the effectiveness of a warning format it is possible to conclude that Prioritised attensons, when used in conjunction with voice messages, provide the most effective means of transferring warning information to the pilot. Attensons generally are shown to have a valuable role to play in the warning format even in the non-specific form of a short 1KHz tone.

Keyboard format also plays a role in subject response times, although this is not as clearly defined as the effect of warning format. A 'Blocked' keyboard, where priority warning keys are grouped together allows subjects to respond faster to warnings than a 'Scrambled' keyboard where the priority warning keys are randomly placed. The advantage of a Blocked keyboard is more pronounced when the warning format does not contain an attenson and reaction times are slower.

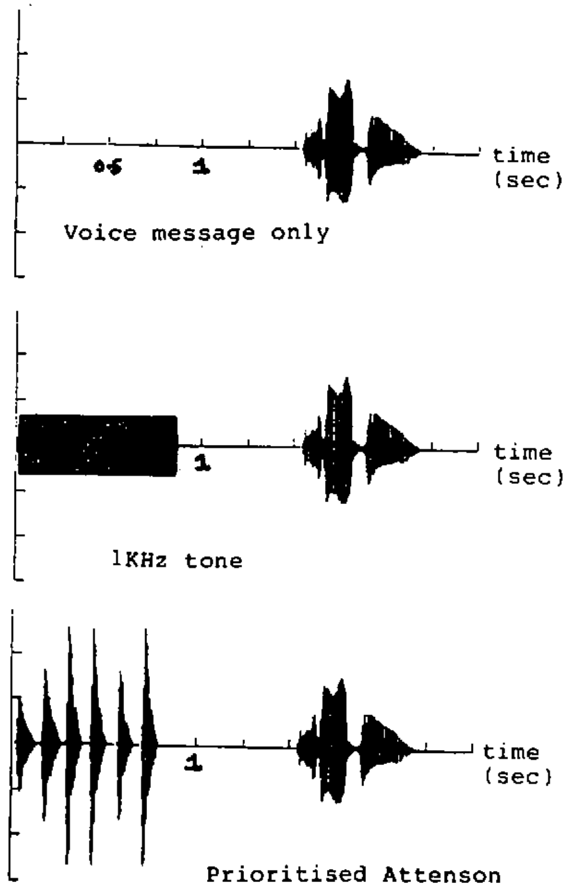

Figure 1 Time sequences of warning formats.

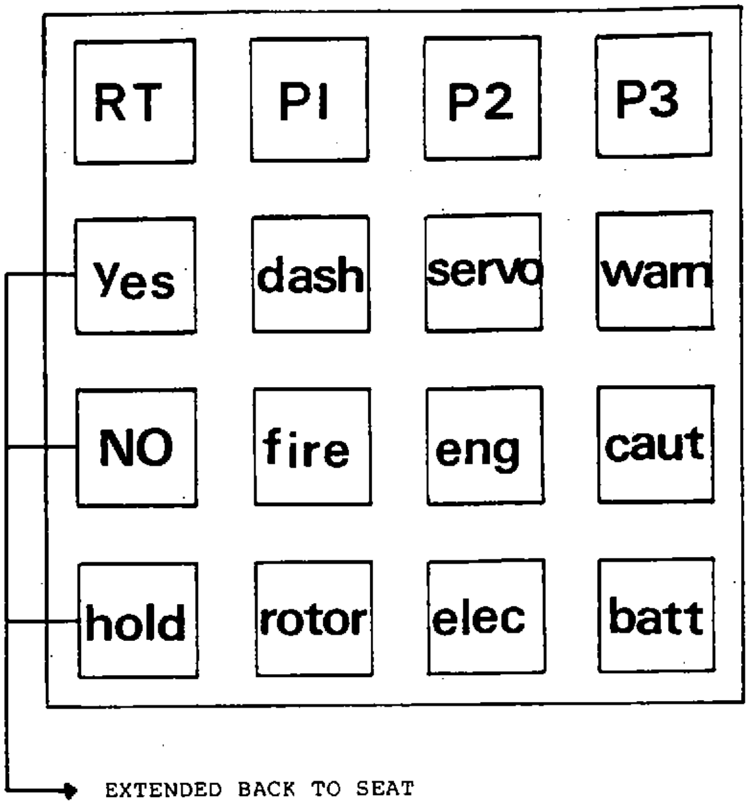

FIGURE 2 Keyboard configuration.

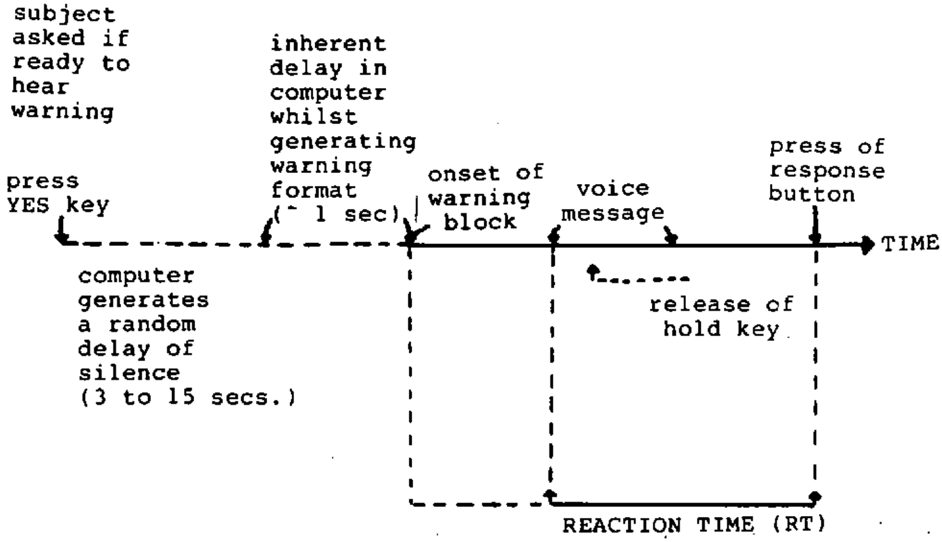

Figure 3 Time sequence for presentation of a warning format and a subject's response to it.

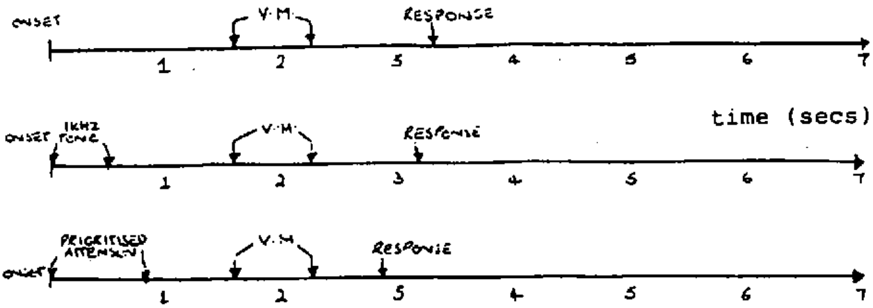

Figure 4a Time sequences of warning formats (UK) and response times.

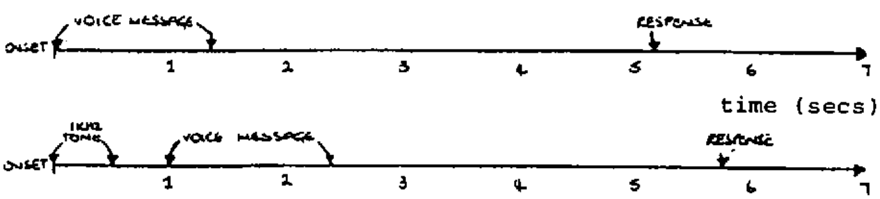

Figure 4b Time sequences of warning formats (US) and response times.

TABLE 1

EXPERIMENTAL DATA - MEAN REACTION TIMES (msec)

RESULTS SUMMARY

EXPERIMENTAL CONDITIONS : 1 = NO ATTENSON, VOICE MESSAGE ONLY
2 = 1KHZ TONE + VOICE MESSAGE
3 = PRIORITY ATTENSON + VOICE MESSAGE

KEYBOARD FORMAT : BLOCKED

Ss No	Condition 1	Condition 2	Condition 3
1	1.659	1.511	1.245
2	1.990	1.648	1.440
3	1.623	1.611	1.191
4	1.131	1.774	1.752
5	1.626	1.694	1.353
6	1.560	1.616	1.294
7	1.552	1.435	1.221
8	1.949	1.857	1.337
9	1.907	1.755	1.391
10	1.657	1.554	1.294
11	1.907	1.908	1.335
12	1.853	1.862	1.394

KEYBOARD FORMAT : SCRAMBLED

Ss No	Condition 1	Condition 2	Condition 3
1	1.735	1.680	1.301
2	2.074	2.097	1.548
3	1.571	1.512	1.211
4	2.646	1.812	1.457
5	1.938	1.576	1.475
6	2.043	1.667	1.296
7	1.681	1.461	1.205
8	1.772	2.200	1.395
9	2.049	1.832	1.577
10	1.604	1.562	1.357
11	2.257	1.886	1.482
12	2.077	2.015	1.477

TABLE 2

EXPERIMENTAL DATA - PAIRED T TESTS

RESULTS SUMMARY

EXPERIMENTAL CONDITIONS : 1 = NO ATTENSON, VOICE MESSAGE ONLY
2 = 1KHZ TONE + VOICE MESSAGE
3 = PRIORITY ATTENSON + VOICE MESSAGE

BLOCKED KEYBOARD:	1 v 2	t=-4.24	p<0.001	***
	1 v 3	t=-22.95	p<0.001	***
	2 v 3	t=-17.74	p<0.001	***
SCRAMBLED KEYBOARD:	1 v 2	t=-5.43	p<0.001	***
	1 v 3	t=-20.30	p<0.001	***
	2 v 3	t=-15.79	p<0.001	***
BLOCKED KEYBOARD v SCRAMBLED KEYBOARD:				
	1 v 1	t=5.95	p<0.001	***
	2 v 2	t=3.47	p<0.001	***
	3 v 3	t=3.44	p<0.001	***

TABLE 3

EXPERIMENTAL DATA - ANOVA
RESULTS SUMMARY

TWO WAY ANOVA : KEYBOARD FORMAT v AUDIO WARNING FORMAT

SOURCE OF VARIATION	SS	DF	MS	F-SCORE	
KEYBOARD	142.1476	2	71.0738	385.8888	p<0.01
CONDITION	8.7476	1	8.7476	47.4945	p<0.01
KEYBOARDxCONDITION	1.9262	2	0.9631	5.2291	p<0.01
WITHIN CELLS	595.6450	3234	0.1842		
TOTAL	748.4665	3239			
GRAND MEAN	1.6572				

THREE WAY ANOVA: KEYBOARD FORMAT v AUDO WARNING FORMAT v SUBJECTS

SOURCE OF VARIATION	SS	DF	MS	F-SCORE	
CONDITION	142.1511	2	71.0755	477.3954	p<0.01
KEYBOARD	8.7476	1	8.7476	58.7552	p<0.01
CONDITIONxKEYBOARD	1.9261	2	0.9631	6.4687	p<0.01
SUBJECTS	79.3618	11	7.2147	48.4592	p<0.01
CONDITIONxSUBJECTS	22.5146	22	1.0234	6.8738	p<0.01
KEYBOARDxSUBJECTS	4.4355	11	0.4032	2.7084	p<0.01
CONDITIONxKEYBOARD xSUBJECTS	17.7092	22	0.8050	5.4067	p<0.01
WITHIN CELLS	417.6580	3168	0.1489		
TOTAL	748.5039	3239			
GRAND MEAN	1.6572				

TABLE 4

BASELINE REACTION TIME (BRT) DATA - PAIRED T TESTS RESULTS SUMMARY

BRT BEFORE EXPERIMENTAL SESSION v BRT AFTER EXPERIMENTAL SESSION (FOR ALL SESSIONS, ACROSS ALL SUBJECTS)

t=0.304 N.S.

BRT BEFORE v BRT AFTER FOR EACH SUBJECT

SUBJECT No.	BRT BEFORE (mean)	v	BRT AFTER (mean)	t VALUE	p level	
1	1.0125		1.0415	1.627	N.S.	
2	1.2607		1.2280	-1.153	N.S.	
3	0.9641		0.9932	2.257	p<0.05	*
4	1.3059		1.3367	2.599	p<0.01	**
5	1.1106		1.1707	3.035	p<0.005	***
6	0.9793		0.9560	-1.748	p<0.05	*
7	0.9398		0.8822	-2.411	p<0.01	**
8	1.0196		0.9976	-1.059	N.S.	
9	1.0516		1.1007	2.669	p<0.005	**
10	0.9956		1.0091	1.228	N.S.	
11	1.1777		1.0947	-3.449	p<0.001	**
12	1.1558		1.1545	-0.078	N.S.	

TABLE 5

BASELINE REACTION TIME (BRT) DATA - ANOVA RESULTS SUMMARY

TWO WAY ANOVA : BRT SESSION (BEFORE/AFTER) v SUBJECTS

SOURCE OF VARIATION	SS	DF	MS	F-SCORE	
BRT SESSION	0.0011	1	0.0011	0.0864	NS
SUBJECTS	20.4600	11	1.8600	137.9301	p<0.01
BRTxSUBJECTS	0.7162	11	0.0651	4.8284	p<0.01
WITHIN CELLS	19.0949	1416	0.0134		
TOTAL	40.2724	1439			
GRAND MEAN	1.0820				