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# Factors Affecting the Successful Reading of Technical Instructions

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This paper describes a procedure for investigating the reading of instructions (using a video-camera set up). The experimental task was the setting of a digital alarm clock using the manufacturer's instructions. The performance of a small sample of subjects was studied against two parameters: degree of competence in English and the extent of experience in scientific fields. Results show that once a threshold in English reading ability has been passed, field-familiarity is a much stronger indicator of rapid and successful text processing than native-like competence in the language. The paper closes with a discussion of implications both for the teaching of technical English and for research into reading technical instructions.

## INTRODUCTION

Instructional reading matter comes in many shapes and sizes - from a few words in miniscule print on a medicine bottle label, or a small card on the back of a plug outlining wiring procedures, to a manual for the maintenance of jet aircraft running to a dozen heavy volumes. This enormous range of written material, varying widely in length and in the level of technical sophistication presumed of the readership does, however, share a common communicative purpose. It is designed to ensure that certain goal-orientated physical actions are carried out as effectively and efficiently as possible. The reader of instructional material, therefore, is not surprised to find that the writer, in an effort to achieve the desired smooth operation of the task, may often include descriptive and explanatory statements which motivate and justify the procedures being advocated. The physical actions triggered by the instructions may involve the sense-organs (as in recipes) or several parts of the body (as in dance or sport training manuals) but most typically concentrate on hand movements. These hand movements can be broadly differentiated into *scribal* and *non-scribal.* Scribal materials require a graphic response, characteristically completing the myriad types of form endemic in modern society. The particular problems of processing such texts have been comprehensively investigated by e.g. Wright 1979 and by the Document Design Centre (e.g. Felker 1980). Our concern, however, is with technical instructional materials that anticipate a non-scribal response - in other words, with those that require the reader to do or make something.

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Native speakers (NS) are known to have problems with technical instructions. According to Simon and Hayes (quoted in Wright 1981) "following instructions is one of the most difficult tasks encountered in daily life" and Wright (1981) notes "indirect support for this comes from the observation that people often prefer not to read instructions". Non-native speakers (NNS) will certainly have any such difficulties intensified by unfamiliarity with technical lexis and probably in other ways as well. Nevertheless, non-native speakers of English in many countries of the world and in many occupations spend part of their working lives referring to English-language technical manuals - in laboratories, in factories, in workshops, in spare parts sales points, in military establishments and in sundry other places. Furthermore, referring to manuals may be the only type of English reading that many NNS engage in and, indeed, may well be the only English-language skill that they customarily exercise.

Given all this activity, it is hardly surprising that Reading Technical Instructions is often a major element in courses that teach English for occupational or vocational purposes, particularly in EFL technical secondary schools and technician training establishments. It is therefore expected that ESP practitioners have given some attention to the linguistic and discoursal features of technical instruction texts (Ewer and Hughes Davies 1974; Trimble and Trimble 1977; Swales 1982). Some of the iterated conclusions from these studies are as follows:

(a) The texts are highly formatted.

(b) Verbal-visual linkages are both frequent and elaborate.

(c) Informational and instructional elements can be difficult to separate.

(d) Locative expressions are frequent and complex.

(e) Equally common are expressions of sequencing and contingency (if x happens, do y)

(f) There is frequent ellipsis (especially of articles, auxiliaries and the complements of Imperative verbs).

(g) Abbreviations, acronyms and symbols abound.

(h) The vocabulary load is particularly heavy with regard to instructional verbs.

(i) The "hedging" modals of academic discourse (*might, could, would*) are rare, but *should, can* and *may* are pervasive.

(j) Elaborate pre-modifications (often containing numerical elements) of noun-phrases are typical, especially in non-introductory sections.

There is also a useful literature on methods for teaching NNS to cope with English-language technical instructions (Ewer and Hughes Davies 1972; Ewer 1977; Hara 1978; Horzella 1979). The over-arching pedagogical recommendation of these papers is neatly expressed by Ewer and Hughes Davies: "the methodology for teaching instructional English is essentially enactive and manipulative". In other words, there has developed a general perception that the real-world requirements of non-scribal response should be introduced into the ESP classroom, and consequently, that there is little place for developing competence in coping with technical instructions via the *answering* of comprehension questions, open, true-false, multiple-choice or whatever.

The appropriate tasks are those of physical arrangement, assembly, disassembly and so on, and success and failure in such tasks can only be viewed in terms of manipulatory response as textual reaction, and little by scribal movements.

However, we have not been able to trace any studies of what actually happens when NS/NNS users of instructional material attempt to carry a task to completion. It is the purpose of this paper to describe some preliminary experimental observations of the "read and do" process and to relate these observations to three variables: the subjects' level of English proficiency, the existence or otherwise of technical and scientific background, and thirdly, the strategies adopted.

## PROCEDURES

### (a) The Tasks

Each subject was given a small sheet indicating the two tasks to be carried out, a small portable digital alarm clock and the manufacturer's leaflet of instructions for the clock (subsequent interviews showed that none of the subjects had any previous familiarity with the particular clock chosen, a Casio MA-5). The assigned tasks were:

(i) Set the time for now
(ii) Set the alarm for 7.30 tomorrow morning

The leaflet contains 32 small pages (approx. 11 x 6 cm) giving the same information and instruction in four languages: English, French, Spanish and Japanese. The eight-page English version, which comes first, is structured as follows:

*Fig 1:* Structure of Information Leaflet, English Version

| Page 1 | Page 2 |
|---|---|
| Diagram of the digital clock | Functions of selector and buttons |
| **Page 3** | **Page 4** |
| Reading of the display | - Setting regular time<br>- Readjusting an error up to 30 seconds<br>- Hourly time signal |
| **Page 5** | **Page 6** |
| Setting alarm time | - Battery maintenance<br>- Care of the unit |
| **Page 7** | **Page 8** |
| Specifications | Warranty Certificate |

As figure 1 indicates, it is pages 1 - 5 that are relevant to the completion of the two assigned tasks.

**(b) Observation of the Tasks**

Because we were interested in the nature of the interaction taking place between the user, the leaflet and the device, the task-sessions were videotaped. Obviously a permanent record of the interaction is essential for subsequent detailed analysis, but this type of videotaping with low-budget single-camera equipment was not without its problems. Ideally, we would have liked a record that indicated all the subjects' motor movements, showed their facial expressions while attempting the tasks, and also displayed in some detail the pages of the leaflet the subjects were dealing with. The smallness of the print in the leaflet led to problems of focus and in retrospect we recognised that the analysis of the tapes would have been made easier if we had colour-coded each page of the leaflet with a different marker-pen. After trial and error, we reached a working compromise whereby we managed to capture all the motor movements, something of the psychological reactions, and (with occasional doubts) a record of which pages were being referred to at any particular moment.

Immediately after the videotaping sessions the tape was rewound and the subjects asked to comment on their performance as it was being replayed to them. The subjects were then asked to summarise the strategies they had adopted and to reflect more generally about both their attitude to reading technical instructions and about their previous experience with this type of reading and of its importance in their chosen field of study.

**(c) The Subjects**

A sample of 12 subjects (all students at the University of Aston) was set as being of reasonable size for a preliminary investigation. As our purpose was to investigate the relative effects on performance of English proficiency and technical experience, we looked for students falling into four categories:

(a) Native speakers with a Science background

(b) Native speakers with an Arts background

(c) Non-native speakers with a Science background

(d) Non-native speakers with an Arts background

Because the non-native speakers were all students at the Language Studies Unit, we were able to ask their regular teachers to assess their General and Reading competence according to the British Council's ELTS band-scale (*Band 1 - Non-user: either has little or no knowledge; Band 9 - Expert user: fully functional command of the language*). We assumed that NS or NS-equivalent competence would be Band 9. We obtained either three or four teacher-assessments for each NNS subject and averaged the results. One overseas student (a Dutch research student in Applied Linguistics with six years' residence in the UK) was consistently rated as Band 9 and was therefore deemed to have a native-like competence in English. There was very little difference between General and Reading assessments and so only the Reading rankings for the groups of Subjects are given below.

*Fig 2:* English Language Proficiency (Reading)

| Category | Number of SS | Band | Range |
|---|---|---|---|
| (A) NS/Science | 3 | 9 | n.a. |
| (B) NNS/Science | 4 | 5.4 | 3.5-7.0 |
| (C) NS/Arts | 2 | 9 | n.a. |
| (D) NNS/Arts | 3 | 7.9 | 7.7-8.0 |

## RESULTS

### (a) Speed of Task Completion

The simplest evaluation of the recorded data is to measure how long the subjects took to complete the two tasks they were set. The overall results are shown in figure 3.

*Fig. 3:* Speed of Task Completion

| Category | Number of SS | Band Average | Time Average (secs) | Range (sec) |
|---|---|---|---|---|
| (A) NS/Science | 3 | 9 | 221 | 173-243 |
| (B) NNS/Science | 3[1] | 5.4 | 355 | 313-385 |
| (C) NS/Arts | 2 | 9 | 512 | 478-547 |
| (D) NNS/Arts | 2[2] | 7.9 | 524 | 405-643 |

[1] One student in this category, an Iraqi taking a postgraduate Diploma in Chemical Engineering, had, after twenty minutes, only completed the first task and was showing no signs of making progress with the second one. She was stopped. She had the lowest ELTS banding *(Band 3: Extremely Limited User: below level of functional competence so that she has to strain to make out the message; constant blocks in Communication)*

[2] One student, a Moroccan taking a Master's course in the teaching of ESP, gave up both tasks after four minutes. When interviewed he explained as follows:

> 'First of all, I have been asked to set up the regular time for now. Now, what I did the first thing I went to "Setting regular time". I have here some instructions, so "Set the selector to time". This is the first action I am going to do. Then "Press A or B to set hours and minutes". Where is the A and B? I do not know where they are because it is specified here 'A and B' so I do not see where is the A and B to set hours and minutes. Check whether AM or PM, I see it is PM but I do not see which button I should press to get the A or B'.

Alone of the twelve subjects, this student was unable to make the necessary tie-up between i) the labelling of A and B on page 1 of the leaflet and ii) the operation of the A and B buttons on the following four pages, and then relate both of these to manipulating the clock controls.

The results for the four different groups indicate that science background is a greater facilitator of efficient completion than very good knowledge of English. This trend emerges more clearly if the subjects completing both tasks are ranked individually for English proficiency and task completion time. The three NNS students taking Science or Engineering courses were the three adjudged to have the weakest English, yet they were the fourth, fifth and sixth fastest to finish. On the other hand, the two NS Arts students were the two slowest (except for one of the NNS English specialists). We would therefore like to propose the following two hypotheses:

(i) There is a *threshold* level of English proficiency without which such reading tasks cannot effectively be done, and that this level may lie somewhere around ELTS Band 5.

(ii) Above that threshold either *field-familiarity* or, more likely, familiarity with the genre of technical instructions is the most important predictor of success. (The top six subjects were all students of Science or Engineering — the one ranked fifth had an ELTS assessment of only 4.8 —, whereas the four Arts students, either native speakers or with high ELTS assessments occupied the bottom four places).

**(b) Text-time, Machine-time and Strategy**

The evaluation of performance we have given in the preceding section is undoubtedly simplistic, especially as far as reading processes are concerned. After all, it is conceivable that some students completed the tasks entirely by trial and error manipulation of the clock's controls and without any reference to the leaflet. Therefore, in order to investigate what actually happened during the completion of the tasks, we undertook a detailed analysis of six subjects: two each from Groups A and B and one each from Groups C and D. In the first place, we were interested in the amounts of time spent on reading and on manipulating. We were also interested in the number of major *reading episodes* (concentrated periods of leaflet study) and the extent to which the students engaged in rapid back and forth eye movements between the machine and the leaflet or "cross glancing". The results are shown in the following figure:

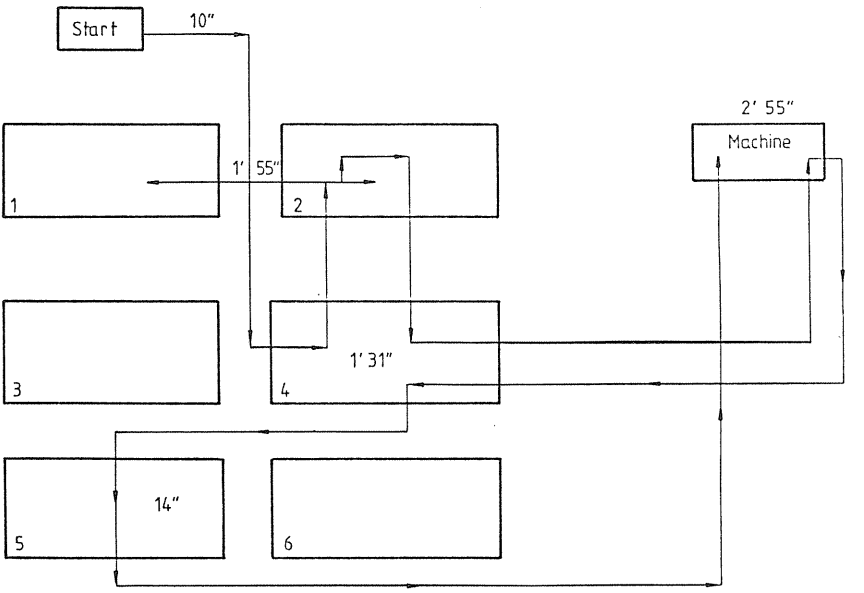
*Fig. 4:* Text-time, Machine-time and Type of Reading

| Subject Category | Total Time | Text-time | Machine-time | Episodes | Cross Glancir |
|---|---|---|---|---|---|
| S1) NS/Science | 173 | 93 | 80 | 2 | high |
| S2) NS/Science | 243 | 83 | 160 | 3 | low |
| S3) NNS/Science | 313 | 123 | 191 | 4 | high |
| S4) NNS/Science | 366 | 174 | 192 | 5 | high |
| S5) NNS/Arts | 405 | 230 | 175 | 4 | none |
| S6) NS/Arts | 478 | 136 | 342 | 5 | low |

The results summarised in Figure 4 go some way towards filling out the procedural details. We can see that four of the subjects spent between 83 and 136 seconds (approximately) on reading the leaflet. Two students, S4 and S5, spent rather longer.

S4, a Libyan taking a Master's degree in Pharmacy, in fact followed roughly the same strategies as all the other Science students except one, but processed the text more slowly because of his limited competence in English. S5, on the other other hand, studied and scrutinised much of the leaflet very carefully, including parts clearly irrelevant to the performance of the two tasks. Further, as the route-map in Figure 5 shows, he went directly to page 4, which contained the instructions for completing the first task.[3] When interviewed, he said that one of his regular reading habits was "to go directly to sections which I think are immediately relevant". As a result, he was unable to interpret the letters A, B, C and D on page 4, because these letters are explained on pages 1 and 2. He then spent nearly two minutes studying the first two pages. In interview, he also commented that he was disturbed by not knowing the word *snooze*. In fact, none of the NNS knew this word, which is not directly relevant to the assigned tasks, but the Science NNS subjects were clearly much less inhibited by such lexical ignorance. This subject maintained on reviewing his performance that his problems were partly due to unfamiliarity with such machines and with this type of instructional material. He also complained that the print was very small (he was wearing glasses) and that the text had "many arrows, numbers and letters".

*Fig. 5*: Route-map of S5 (NNS Arts)

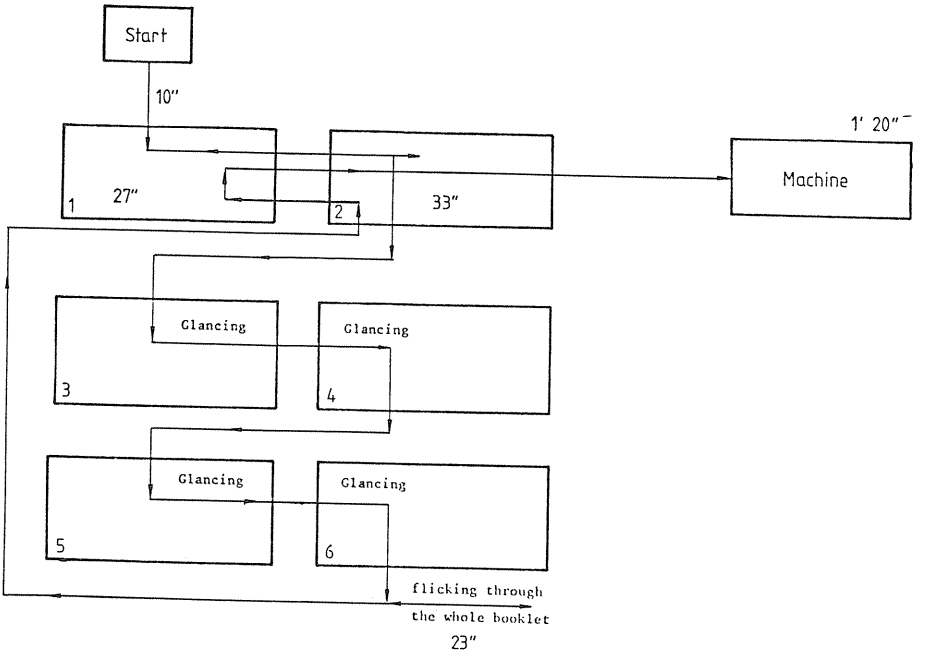



[3] The route-maps in Figures 5-7 may need a little explanation. On each route-map the six numbered boxes represent the first six pages in the leaflet. The time spent on each page is placed inside the box. If the time is placed between two boxes it indicates the time spent on both pages. The use of a double-ended arrow across two pages indicates that the subject was moving from one page to the other in such a way that it was impossible to estimate the time spent on one page.

The continuous arrowed line from *start* to the completion of the tasks traces the focus of attention of the subject from leaflet to device and back again (and so forth).

The Machine-time results are also quite interesting. The exceptional manipulatory performance of S1 was at least partly due to the fact that he already knew from previous experience with electronic timesetting controls that continuous pressure on the button was much quicker than a rapid series of jabs. His processing of the text was also strikingly different to that of S5. As figure 6 shows, he concentrated his reading on the first two pages and from his knowledge of the diagram and the control functions was able to complete the tasks with only cursory glances at the actual instructional steps on pages 3-5.

*Fig. 6*: Route-map of S1 (NS, Science)

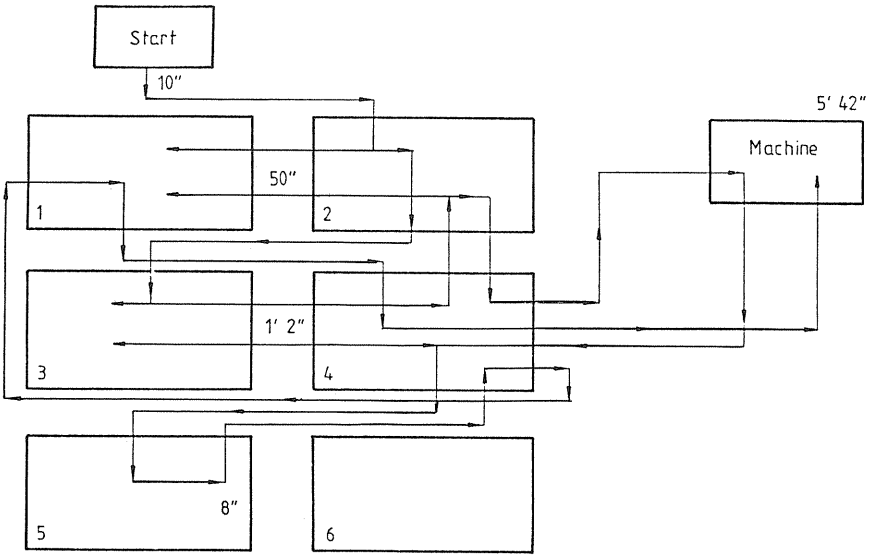



S2 and S6 spent much longer on the machine than on the leaflet. In S2's case this was because he alone of the six adopted an initial *machine-experimentation* strategy rather than one based on prior examination of the leaflet. Such early familiarity with the device also explains the relative absence of glancing back and forth between the digital clock and the leaflet in that it would seem that this subject was able to retain an adequate memory of the device when reading the text.

The route-map of the Arts native speaker is much more complex (see figure 7), although the actual time she spent reading the text was about average, thus suggesting a capacity to read rapidly.

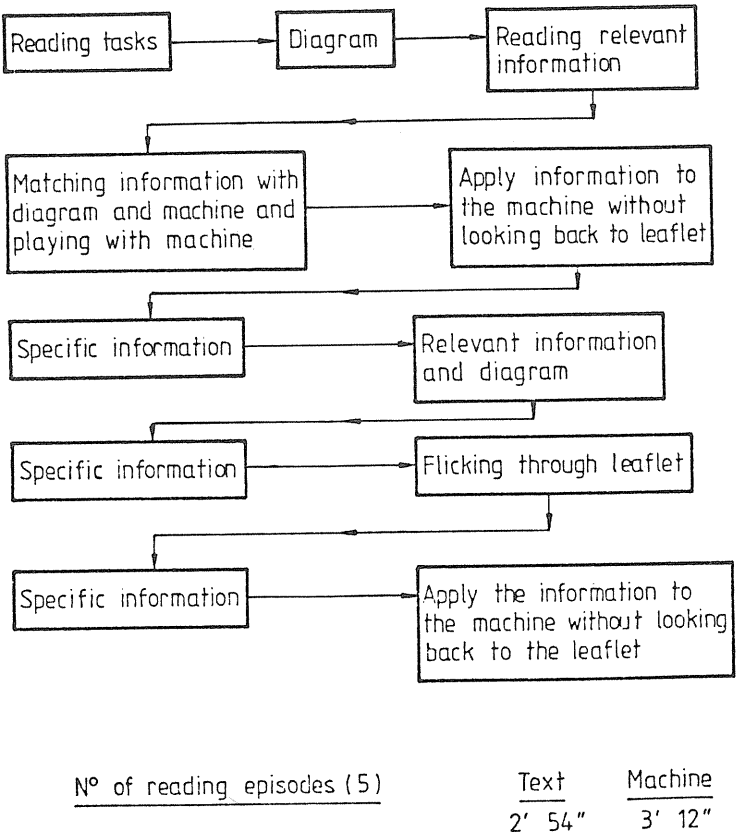
Her difficulty apparently came in manipulating the machine; and examination of the videotape shows that she never really understood the function of Control B (which is to retard the time) but over-relied on Control A (which advances the time). It is worth observing that this subject stressed several times in both the playback and the interview that she was familiar with digital watches and how to adjust them, but not with digital clocks. Digital watches rarely have a control for running the time backwards.

*Fig. 7*: Route-map of S6 (NS, Arts)



The purpose of the route-maps was to present a summary visual trace of the eye and hand movements captured on the videotapes. They had been deliberately non-interpretative of what we thought might be happening in terms of the subject's aims and of their learning and memory processes while they were completing the tasks. Subsequently, we felt we ought to attempt somewhat more interpretative flowcharts of the various performances. One of these is given below (fig 8). We have chosen subject 4, who emerged, because of his weak English, as 'the star of the show' and certainly there is some reason to think that he has followed a highly effective strategy for carrying out two tasks that rely on reading technical instructions and interrelating that reading with manipulating the controls of a small device.

*Fig. 8*: Strategy of subject 4 (NNS, Science)



## DISCUSSION

We have reason to believe that the actual processes of reading technical instructions have been somewhat neglected by those concerned with reading in a foreign language, with preference being given to analysis of instructional texts or to preparing exercises for teaching comprehension of instructional English. Although useful work has been done in both those areas, there has remained some uncertainty about which assets and liabilities non-native speakers of differing background and experience bring to instructional reading tasks. Although the work reported here is very small scale (indeed rather more in the nature of being a series of mini case studies than of a properly established experiment with large carefully differentiated and carefully pretested groups of subjects) it has, we believe, offered a number of pointers for the future, both in procedure and in hypothesis.

In the first place, it seems to us that videotaping facilities offer the reading researcher an investigative tool of considerable power especially in *read and do* situations such as the one described in this paper. We would also like to think that potentially such videotapes have their uses for both EFL/ESP students and teachers, particularly as records of successful and less successful strategies. However, the poor quality of our own recordings has precluded their actual use for these purposes.

In the second place, the results reported here suggest a number of areas for further investigations. Although common sense might predict that technical experience would play *some* part in determining the speed at which successful nonscribal responses to technical instructional texts become completed, we have been surprised at the apparent strength of its influence and by the apparent unimportance of general English proficiency above a presumed threshold level. It would be useful to have further studies that would confirm or disconfirm this preliminary weighting of the two variables. The relative failure of the Arts students would appear ascribable to a range of causes. One freaked out after four minutes presumably due to loss of self-confidence, another approached the leaflet as though it were an informational textbook rather than an instructional manual, and the third was apparently hampered by a belief that the control mechanisms of the digital clock were simpler than was in fact the case. Further information about the *patterns* of difficulty would be useful to manual writers, and to materials writers and teachers concerned with improving the processing of instructional texts by both native speakers and non-native speakers.

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