On the use of computerised decision aids
Dijkstra, Jacob Jan

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Chapter 3

Compliance with expert system advice

3.1 Introduction

The previous chapter gave an overview of the functioning of an expert system and some difficulties of expert system construction were pointed out. These difficulties lie in the restriction of the knowledge domain, different opinions of experts, the use of common sense knowledge, and management problems. This can affect the knowledge base of the expert system and, consequently, corrupt the inference process. As a result, the expert system can make incomplete or even incorrect inferences. Thus, the advice of an expert system can be questionable and, as a consequence, the user of the expert system should determine the applicability of the advice. Therefore, adequate explanation facilities and a good user-interface must provide the user with the necessary information to make this judgement. The expert system should offer the user the opportunity to examine the advice by giving an insight into the inference process, the knowledge rules, and the knowledge sources.

This chapter deals with the question whether or not users examine the advice of an expert system. Research on users' behaviour shows that users sometimes neglect their task to examine the contents of information provided by a computer. The first part of this chapter gives an overview of studies concerning this problem. These studies show that users often overvalue the usefulness of information systems and believe that they come to better conclusions with the help of the information system when, in fact, the computerised aid does not improve their decisions. This raises the question: why do users have an unjustified confidence in computerised aid?
The second part of this chapter tries to answer this question from a theoretical point of view. It outlines the Elaboration Likelihood Model, a social psychological model of persuasion. According to this model, recipients do not always pay attention to the contents of a message because they often use simple cues, such as beliefs about the communicator, when they evaluate a message. If users of expert systems behave in a similar way, then these users may accept (or reject) the advice of the expert system without critically examining the advice. Chapter 5, 6, and 7 describe three experiments in which this assumption is tested.

3.2 Incorrect judgement of the usefulness of computer support

The literature reports several studies of the possible improvement of decision making with the help of computer programs. Several of these studies show that the use of computerised aids improves users' confidence in decision making without correspondingly improving the quality of their decisions. These results indicate that users sometimes have difficulties in judging the usefulness of computer support. The experiments are discussed in detail below.

It is important to note that not all the experiments mentioned in this section are with expert systems. Some of them concern Decision Support Systems and some concern Management Information Systems. The distinction between expert systems and these other types of information systems is vague. Management Information Systems support decision making through the use of (mathematical) models (Watson & Hill, 1983) and Decision Support Systems are sometimes referred to as second generation Management Information Systems (Parker & Al-Utaibi, 1986). That is, a Decision Support System is an interactive computer-based information system that uses models and decision rules, coupled with an extensive database (Turban & Watkins, 1986). Management Information Systems and Decision Support Systems help the user to structure the decision process, but unlike expert systems they do not draw conclusions nor do they make recommendations; decision making itself is left out of the information system
Compliance

(de Boer, 1994; Turban, 1993). However, some researchers argue that artificial intelligence techniques should be used within Decision Support Systems (Goul, Henderson & Tonge, 1992; Wong & Monaco, 1995), so the distinction between expert systems and Decision Support Systems becomes even more vague.

Here the dissimilarity between research on Management Information Systems, research on Decision Support Systems, and research on expert systems is not essential. It does not make much difference whether a user puts trust in information from a Decision Support System or advice inferred by an expert system. Therefore, literature on user aspects of Decision Support Systems and Management Information Systems is also considered relevant to expert systems.

Several studies have shown that individuals who used a computerised decision aid had higher confidence in their decisions but the quality of their decisions did not improve correspondingly. An example of such a study is an experiment by Aldag and Power (1986). In this experiment half the subjects first made a strategic-management decision with the help of a computerised decision-analysis aid and, one week later, a decision without the decision aid; the other subjects used the decision aid only when they made the second decision. Independent raters reviewed the subjects' decision reports. The results showed that the computerised decision-analysis aid did not improve the ratings on the subjects' decision reports. However, when subjects used the computerised decision-analysis aid, they exhibited more confidence in the decisions they made. Thus, these subjects had a heightened decision confidence without corresponding improvements in decision quality.

In an experiment on a financial statements analysis task, Davis, Lohse, and Kottemann (1994) also found that subjects misjudged the helpfulness of information systems. In their experiment an information system provided subjects with redundant (group 1) or non-redundant (group 2) information about a financial case. Compared to the condition in which subjects did not use an information system (group 3), non-redundant as well as redundant information reduced forecast accuracy while increasing confidence. Thus, the results confirm the findings of Aldag and Power: subjects had faith in an information system that did not improve their decisions. Moreover, this
study shows that subjects put confidence in the information system, whatever the contents of the information.

Davis and Kottemann (1994) studied the `illusion of control' effect of a method called what-if aid. What-if aid is a method for manipulating business models by specifying alternative values of decision variables and environmental assumptions. The computer program solves the model and then displays the predicted results. Decision Support Systems often have a what-if function. Davis and Kottemann found that subjects supported by a what-if analysis did not fulfil a decision task better than unaided decision makers. Yet, the users believed that the what-if aid was beneficial and they overestimated how much the what-if analysis helped their performance. In an additional experiment subjects believed that decision making with the help of what-if analysis was superior to unaided decision making, but they actually performed significantly worse when they used the what-if aid (Kottemann, Davis & Remus, 1994).

In an experiment on the use of an expert system for the interpretation of well tests for oil and gas exploration, Will (1992) found that subjects who used the expert system did not make better decisions than subjects who solved the problem manually. However, expert system users did have more confidence in their decision. Thus, Will demonstrates that users of expert systems, like users of other types of information systems, have difficulties in judging the helpfulness of their decision aid.

All these experiments show that users sometimes make inferior, and sometimes even incorrect, judgements of the helpfulness of computerised aid. In a literature review of experiments on user preference versus performance Nielsen and Levy (1994) found that there are many cases in which users are satisfied with computer systems that actually make them perform worse. Although most of these experiments were on the interface design of various computer programs and not just information systems, the results add to the conclusion that users sometimes prefer to use computer programs that are not beneficial to them.

Interaction with a computer program is not a crucial factor for the unjustified decision confidence. Murphy and Yetmar (1996) report that supervisors took more confidence in reports believed to be made by a
colleague who used an expert system than reports that were not made with the aid of an expert system. Also, the supervisors agreed more often with these reports and they judged the answers they perceived as computer answers as being more trustworthy and more comprehensible.

In all, these experiments show that users sometimes have an unjustified confidence in decisions based on computerised information. However, these studies do not answer two important questions. First, they do not explain why users of information systems sometimes have an unjustified confidence in their computerised aid. The next section discusses the Elaboration Likelihood Model, a model of persuasion, which might explain this behaviour. The model clarifies what makes people put their trust in messages. Chapter 6 and 7 cover two experiments in which the Elaboration Likelihood Model is applied to study the behaviour of users of expert system. Secondly, the experiments presented above do not deal with the problem whether or not users can detect when an expert system gives incorrect advice on a problem. They only show that users sometimes overvalue (correct) information presented by an information system. However, when users misjudge the importance of redundant information, they may also misjudge the incorrect advice of an expert system. To verify this assumption Chapter 5 and 7 cover two experiments in which subjects are supported by an expert system that gives incorrect advice.

3.3 Theoretical models of persuasion

3.3.1 The Elaboration Likelihood Model

The Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986a, 1986b) is a social psychological model of persuasion. Persuasion is the psychology of attitude change (Worchel, Cooper & Goethals, 1988). Petty and Cacioppo assume that people desire to attain correct attitudes and therefore process information. However, the extent and nature of processing information to form a correct attitude depends upon a person's motivation and ability for issue-relevant thinking. The term elaboration in the ELM
refers to the extent to which people think about issue-relevant arguments contained in a persuasive message.

When situational and individual differences ensure high motivation and ability for issue-relevant thinking, the elaboration likelihood is said to be high. Consequently, the probability is relatively high that recipients of the message follow the central route to persuasion (see Figure 3.1). That is, persuasion is likely to result from a person's careful examination of the information contained in the message and thoughtful consideration of the merits of the information presented.

![Figure 3.1 A simplified version of the ELM.](image)
When the motivation and ability are low, the probability is relatively high that recipients of the message will follow the peripheral route to persuasion (see Figure 3.1). Persuasion through the peripheral route means that attitudes are determined by positive or negative cues in the persuasion context that either becomes directly associated with the message position or permit a simple inference about the validity of the message. The term peripheral cue refers to any variable that can affect persuasion without affecting argument scrutiny. For instance, a scientific report presented by someone who looks like a professor can be more convincing than the same report presented by someone who looks like a cheerleader.

To summarise, Petty and Cacioppo argue that people may adopt attitudes on bases other than their understanding and evaluation of a persuasive message, and the ELM provides an empirical framework to study this phenomenon. The ELM has been tested and confirmed in many experiments and it has contributed to a resurgence of interest in persuasion processes among social psychologists.

Petty and Cacioppo have studied several cues that might influence the attitudes of recipients through the peripheral route to persuasion. According to the ELM the number of arguments in a message might affect persuasion by serving as a simple peripheral cue. Petty and Cacioppo (1984) examined this hypothesis in a 2 (Motivation: low or high) by 2 (Argument quantity: 3 or 9) by 2 (Argument quality: weak or strong) between-subjects experiment. The persuasive message was about policy changes at a particular university. Subjects, who were students at this university, were expected to be highly motivated when changes would take place the following year. Low motivation was expected when changes would take place in 10 years. When students were highly motivated, the number of strong arguments enhanced persuasion; when the quality of the arguments was weak, increasing their number reduced persuasion. However, when the students were less motivated, both weak and strong arguments enhanced persuasion when their number was increased. Thus, for individuals who are not motivated to examine the contents of a message, the mere number of arguments in the message can cause a positive attitude shift.

Source expertise can also act as a peripheral cue. Petty, Cacioppo, and
Goldman (1981) examined this hypothesis in a 2 (Motivation: low or high) by 2 (Argument quality: weak or strong) by 2 (Source expertise: expert or inexpert) between-subjects experiment. Similar to the experiment above, the persuasive message was a report on policy changes at a university. The report was either said to be prepared by a local high school class in the low expertise condition, or it was said to be prepared by the Carnegie Commission on Higher Education in the high expertise condition. Source expertise had no effect on attitudes in the high motivation condition; only argument quality was important. Source expertise had a significant effect on attitudes in the low motivation condition: the report of the expert source was more persuasive than the report of the inexpert. Thus, the experiment shows that source expertise can act as a peripheral cue.

Petty and Cacioppo have examined several other possible peripheral cues, such as likability, nonverbal behaviour, pleasant music, etc. All these cues have a more powerful effect on judgements when motivation is low rather than high (Petty & Cacioppo, 1986a).

By playing on subjects' involvement with the contents of a message, experimenters can manipulate the motivation of the subjects to study the contents of the message. However, people also differ in intrinsic motivation and enjoyment to engage in effortful examination of information. Petty and Cacioppo developed the need for cognition scale to measure this individual difference (Cacioppo & Petty, 1982; Cacioppo, Petty & Kao, 1984). According to the ELM, people with a low need for cognition are less motivated to examine the contents of a message, and therefore they are more likely persuaded by peripheral cues than people with a high need for cognition (Petty & Cacioppo, 1986a, pp. 101-105). Table 3.1 gives the item wording of the need for cognition scale (Cacioppo et al., 1984). Pieters, Verplanken, and Modde (1987) translated the need for cognition scale in Dutch. They dropped 3 items from the 18-item scale (see Table 3.1) because these items loaded lower than .30 on the need for cognition factor and did not significantly correlate with the total scale. Cronbach's alpha for the 15-item scale was .83 (n=87) and .75 (n=253) in a follow-up study. This Dutch 15-item need for cognition scale was used in the experiments presented in Chapter 6 and 7.
Table 3.1 The need for cognition scale, which measures the intrinsic motivation and enjoyment to engage in effortful examination of information.

<table>
<thead>
<tr>
<th>Item</th>
<th>Item Wording</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>I would prefer complex to simple problems.</td>
</tr>
<tr>
<td>2</td>
<td>I like to have the responsibility of handling a situation that requires a lot of thinking.</td>
</tr>
<tr>
<td>3</td>
<td>Thinking is not my idea of fun.*</td>
</tr>
<tr>
<td>4</td>
<td>I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.*</td>
</tr>
<tr>
<td>5+</td>
<td>I try to anticipate and avoid situations where there is likely chance I will have to think in depth about something.*</td>
</tr>
<tr>
<td>6</td>
<td>I find satisfaction in deliberating hard and for long hours.</td>
</tr>
<tr>
<td>7</td>
<td>I only think as hard as I have to.*</td>
</tr>
<tr>
<td>8</td>
<td>I prefer to think about small, daily projects to long-term ones.*</td>
</tr>
<tr>
<td>9</td>
<td>I like tasks that require little thought once I've learned them.*</td>
</tr>
<tr>
<td>10</td>
<td>The idea of relying on thought to make my way to the top appeals to me.</td>
</tr>
<tr>
<td>11</td>
<td>I really enjoy a task that involves coming up with new solutions to problems.</td>
</tr>
<tr>
<td>12</td>
<td>Learning new ways of thinking doesn't excite me very much.*</td>
</tr>
<tr>
<td>13+</td>
<td>I prefer my life to be filled with puzzles I must solve.</td>
</tr>
<tr>
<td>14</td>
<td>The notion of thinking abstractly is appealing to me.</td>
</tr>
<tr>
<td>15</td>
<td>I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.</td>
</tr>
<tr>
<td>16+</td>
<td>I feel relief rather than satisfaction after completing a task that required a lot of mental effort.*</td>
</tr>
<tr>
<td>17</td>
<td>It's enough for me that something gets the job done; I don't care how or why it works.*</td>
</tr>
<tr>
<td>18</td>
<td>I usually end up deliberating about issues even when they do not affect me personally.</td>
</tr>
</tbody>
</table>

* Reversed scoring is used on this item.
+ Pieters et al. (1987) dropped this item.

Research on the ELM has shown that individuals high in need for cognition enjoy relative effortful cognitive tasks. Cacioppo and Petty (1982) did a test for simple and complex information processing and need for cognition. In the experiment subjects did a number-circling task with a table containing 3500 random numbers. In the simple number-circling task condition the subjects were instructed to circle all 1s, 5s, and 7s. In the complex number-circling condition the subjects were instructed to circle all 3s, any 6 that preceded a 7, and every other 4. Subjects who had a high need for cognition score preferred the complex to the simple task, whereas subjects low in need for cognition preferred the simple to the complex task.
This test is also used in the experiments presented in Chapter 6 and 7.

3.3.2 The heuristic-systematic model

The ELM is not the only model of persuasion. The heuristic-systematic model (Eagly & Chaiken, 1993) is a social psychological model of persuasion similar to the ELM. In the heuristic-systematic model a distinction is made between heuristic information processing and systematic information processing. The processing of simple decision rules (heuristic processing) is a more limited mode of information processing that requires less cognitive effort and fewer cognitive resources than systematic processing. When processing heuristically, people focus on that subset of available information that enables them to use simple decision rules to evaluate a message. For example, the recipient of a message may look only at the message source to evaluate a message, using the heuristic that the advice of an expert can be trusted. This type of processing is similar to the peripheral route in the ELM. Systematic processing is similar to the central route in the ELM (O'Keefe, 1990). When processing systematically, people focus on their understanding and cognitive elaboration of the argumentation contained in the persuasive message.

To explain which type of processing people use to evaluate a message, Eagly and Chaiken (1993) assume that people are `economy minded souls' who wish to satisfy their goal-related needs in the most efficient ways possible. Their least effort principle says that people prefer less effortful to more effortful information processing. People try to be as efficient as possible in their information processing. The heuristic-systematic model embodies the idea that efficient information processors must strike balance between satisfying motivational concerns and reducing their processing efforts. People will exert whatever effort is required to attain a `sufficient' degree of confidence that they have satisfactorily accomplished their processing goals. People engage in greater amounts of systematic processing when the less effortful heuristic mode leads to insufficient judgemental confidence. Payne, Bettman, and Johnson (1993) argue in their theory about adaptive decision making that the effort concerns of the recipients of a
persuasive message similarly determine by which ELM route recipients will evaluate the message. In some of their experiments Petty and Cacioppo also used cognitive effort measurements to test their ELM (e.g. Cacioppo, Petty & Morris, 1983); the central route is associated with great cognitive effort and the peripheral route is associated with little cognitive effort (Petty, 1994). Thus, although it is not explicitly incorporated into the model, effort concerns support the ELM.

When the ability or motivation for systematic processing is low, the judgemental impact of heuristic cues will often be stronger. Heuristics often exert little persuasive impact when people engage in systematic processing. However, it is important to note that this analysis does not imply that at particular levels of accuracy-motivation only one mode of processing occurs. Rather, heuristic processing may predominate in a low accuracy-motivation setting. In their ELM, Petty and Cacioppo (1986a, 1986b) argue similarly that when motivation and/or ability to process arguments decreases, then peripheral cues become relatively more important determinants of persuasion. Conversely, as arguments scrutiny is increased, peripheral cues become relatively less important determinants of persuasion.

Within the research presented in this thesis the ELM and the heuristic-systematic model are complementary. Eagly and Chaiken (1993, p. 346) argue that: "The empirical strength of the elaboration likelihood model together with the theoretical strengths of the heuristic-systematic model make for a truly impressive dual-processing framework for understanding a variety of social influence phenomena." In short, the ELM and the heuristic-systematic model both provide a general framework for organizing, categorizing, and understanding the basic processes that underlie the effectiveness of persuasive communication.

3.4 Conclusions

The results of the studies described in the first part of this chapter show that decision makers may be led astray when they use a computerised decision aid. As Boden noticed (1990), the way the system reasons is not the
problem, the problem is how users respond to the computerised advice. Users allocate many of their tasks to their computerised aid (Jones & Mitchell, 1995). The ELM gives a social psychological explanation for this behaviour by pointing out that individuals may accept the advice of the expert system without actually studying it. In such a case the expert system would merely function as a persuasive communicator.

According to the ELM the motivation and ability of a recipient of a message decide which route to persuasion the recipient will follow. When we look at the persuasiveness of expert systems, it would be important to know whether a user is motivated to interact with the expert system. Therefore, the next chapter discusses user attitudes towards computers. Then, Chapter 5, 6, and 7 describe three experiments on persuasiveness of expert systems.