USERS' ERRORS AND ERROR HANDLING: ITS RELATIONSHIPS WITH TASK STRUCTURE AND SOCIAL SUPPORT*

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INTRODUCTION

Errors are usually studied in the laboratory. This is useful, but larger impact factors like organizational variables cannot be observed there. In our study, we observed computer users in their ordinary work situation in the office. Organizations have an impact on particular work settings by determining the concrete task structure and the social climate. Traditionally, the two most important task structure variables have been job complexity and job discretion. *Job complexity* of a particular work task influences which errors appear and how they are dealt with. A high level of *job discretion* implies that the workers can decide many issues at work, e.g. the timing, sequencing and the content of plans and goals at work (Frese, 1987).

The two *social climate* factors studied here were social support by supervisors and by co-workers. Social support implies that the supervisor or the co-worker will listen to problems appearing at work, give emotional support as well as actual help. Users who feel that their supervisors support them, will be more likely to ask them for help once they are in an error situation. A similar argument holds for their co-workers support.

An additional organizational factor important for our field is the *organization of the computer advisory service*: One can contrast centrally localized computer advisory services with a decentralized service with local experts (Dutke & Schönpflug, 1987; Scharer, 1983). We hypothesize that the computer advisory service is more often used when it is decentralized because local experts know more about the users' tasks and they are more quickly available.

In error handling we concentrate on the following aspects of error handling: How many errors does a user make (number of errors)? How long does it take to handle the error (error handling time)? This is the time after an error is discovered up to the time the user finishes error recovery. How much outside support is needed for error handling, e.g. by co-workers, by supervisor, by calling up the help system, by asking the computer advisory service, etc.? How useful are the support functions judged to be? How many negative emotional reactions does the user show, once he or she gets into an error situation?

Organizational variables do not affect all kinds of errors in the same way. We have developed an error taxonomy based on theories from Norman (1981), Semmer & Frese (1985), Rasmussen (1987) and Reason (1987). Our error taxonomy, its usefulness and construct validation are shown in Zapf, Brodbeck, Frese, Peters and Prümper (1990). Since the error taxonomy cannot be

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presented here, it may suffice to say that organizational issues should have a higher impact on those errors, that arise in conscious and problem oriented approaches to a task. Here controlled processes and conscious attention dominate. The most important errors that pertain to the conscious approach are: knowledge errors that appear if the user does not know how to deal with a certain task; thought errors that happen, when the steps for dealing with a task are not planned out well; memory errors, when some part of a conscious plan is forgotten; and judgment errors when the feedback of a system could not be interpreted correctly. Thought, memory, and judgment errors are part of the intellectual level of regulation of action (cf. Semmer & Frese, 1985). This means that the problem is consciously and deliberatively tackled. In contrast to the intellectual level of regulation, the lower levels of regulation imply that the actions are routine and only need minimal conscious attention.

In general, the hypothesized relationships between organizational variables and error handling should not be very large. For example, social support by co-workers does not directly translate into asking co-workers for help in an error situation because the co-workers may not know enough about the problem and they may not be readily available. However, small correlations can be important for practical reasons (Frese, 1985; Ozer, 1985).

METHODS

The subjects worked as secretaries, typists, specialists and in lower level management. 170 subjects were both observed and responded to the questionnaire (more details on the sample in Zapf et al., 1990).

Observations of number of errors, error handling time, outside support, and negative emotional reactions: These variables were observed by trained observers during a two hour period. The errors were immediately classified in a taxonomy and were re-rated by two raters afterwards (N = 1306, more on the procedure in Zapf et al., 1990). Due to regulations in the Germany industry, we could not use stopwatches for the error handling time; instead the observers made rough time estimates. For expository purposes, these estimates were then transformed into a real time scale. External support implies using help texts, asking co-workers or supervisors, looking into manual, asking the computer advisory service and asking others outside the company.

The subjects also rated the frequency of their use of external support. These external supports were also ranked on two dimensions, preference ("Whenever you encounter a problem or an error which you have difficulties to deal with, which of the following possibilities do you employ first, second, third etc.") and usefulness of information ("Whenever you encounter a problem or an error which you have difficulties to deal with, which of the following possibilities do you expect to be the best, second best, third best etc. support"). Social support by supervisors and by co-workers were ascertained by a questionnaire (Frese, 1989).

The observers also gave a rough estimate, whether the subjects reacted with anxiety, frustration and anger to errors.

RESULTS AND DISCUSSION

Observed complexity of work was significantly related to the number of errors on the intellectual level of regulation ($r = .25$, $N = 172$, $p < .01$), to error handling time for all errors ($r = .19$, $N = 169$, $p < .01$) and negatively to upsetting emotional reactions ($r = -.23$, $N = 172$, $p < .01$). This is in line with our hypothesis that more complex tasks will lead to more complex errors. Errors may be less upsetting in jobs of higher complexity because they usually allow a more leisurely work style than highly supervised non-complex jobs. *Observed job discretion* showed similar correlations in size and direction.

The social climate at work - social support by supervisors and co-workers - was weakly but significantly related to whether or not supervisors or co-workers were asked for help in an error situation. Social support by co-workers correlated positively ($r = .15$, $N = 216$, $p < .05$) with the frequency of asking co-workers (questionnaire version) as well as social support by supervisors ($r = .17$, $N = 213$, $p < .01$) with the frequency of asking supervisors (questionnaire version).

Observed and self-reported frequencies of supports showed quite a similar picture. Co-workers were relied on most often. They were asked in 60 of 118 cases in which the subjects required any kind of help. The second most frequently used support was observed to be calls on help texts and exploration of menus. Surprisingly users thought that they used the manual more often than we observed them doing it. One possible interpretation is that users have great difficulties with manuals and hence still vividly remember how they used the manual. Thus, recall is better and the number of manual uses is overestimated.

The two questions in the questionnaire "How much do you prefer a certain support to solve an error situation" and "how good is the quality of the information that you receive from these sources of support" showed that asking a co-worker is preferred most often.

Whether or not a supervisor is asked may also depend on how much a user feels to be supported by the supervisor. A group comparison (Kruskal-Wallis, one-way ANOVA) showed that the more social support was given by the superordinate, the higher was the ranking of preference of asking the supervisor ($ch^2 = 10.0$, $p < 0.01$) and the usefulness ($ch^2 = 17.9$, $p < 0.01$) received. A similar tendency appeared for social supportiveness of co-workers with preference for using co-workers ($chi^2 = 7.1$, $p < 0.05$).

We also compared *centralized* and *decentralized computer advisory services*. The computer advisory services were not used very often. However, the computer advisory service was actually considered to be an informative support facility (ranking second best on usefulness), but it was considered significantly less helpful than asking a co-worker. Why is this so? Qualitative analysis of the interview data showed that the computer advisory service was often centrally organized, technically oriented, not task oriented and it was highly overloaded.

In an additional analysis the subjects were grouped according to whether the advisory service of their department was decentrally or centrally organized. The hypothesis was that those people with a decentralized advisory system would use them more frequently and find them more helpful. The average ranking of advisory services differed significantly (Kruskal-Wallis, one-way ANOVA). Decentralized advisory services were used more frequently ($chi^2 = 14.1$, $p < 0.01$). They were ranked higher in preference ($chi^2 = 9.4$, $p < 0.01$) and in quality of information ($chi^2 = 17.0$, $p < 0.01$). These data speak for the usefulness of the local experts because they combine attributes of co-workers with high computer expertise.

In summary, task structure variables show significant correlations with type of error, error handling time and social variables like social support. The organization of the advisory system showed some impact as well. The relationships are by and large small. In so far, this study is suggestive only. Additionally, the data cannot be interpreted causally. Nevertheless, the correlational evidence should be taken to mean that there is a relationship between organizational variables and errors.

The data suggest that it is useful to enlarge the picture of software ergonomics to include organizational variables. It is necessary to develop a comprehensive concept of how organizational variables enter into human-computer interaction and which mechanisms are responsible.

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