

# Grammatical Errors and Feedback – Some Theoretical Insights

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**Abstract:** This article discusses selected theoretical aspects of providing error feedback for language learners. The discussion focuses on feedback for grammatical errors, but many of its tenets appear to be of broader relevance. The theoretical considerations concerning the dialog with the learner about linguistic errors are discussed and some conclusions for CALL system design will be drawn. This discussion focuses on errors in written text production and occasionally draws on examples from parser-based CALL, in particular on insights gained during the work on *Textana* – a prototype of a grammar checker for English-speaking learners of German.

Keywords: Feedback, Learning Theory, Human Computer Interaction, Grammar

## Feedback in CALL - Necessary Hypotheses

If one of the now many CALL enthusiasts attempts to enumerate the advantages of computer-assisted language learning, in order to persuade a (not yet) converted language teacher, the latter might ask the former what the computer (program) can do and the (grammar or text) book cannot. The likely reply is that the computer (program) is praised for its capability of providing immediate feedback. This usually does the trick and establishes the superiority of computers over grammar books - until somebody counters by saying that, of course, good grammar books provide feedback by giving the correct answers in the appendix of the book or in a little booklet which has to be purchased separately ... Now a real discussion on feedback can develop ...

Feedback is most commonly understood as a technical term:

**feedback** a principle used in self-regulating control systems. Information about what *is* happening in a system (such as level of temperature, engine speed or size of a workpiece) is fed back to a controlling device, which compares it with what *should* be happening. If the two are different, the device takes suitable action (such as switching on a heater, allowing more steam to the engine, or resetting the tools). (Upshall, 1993, 337)

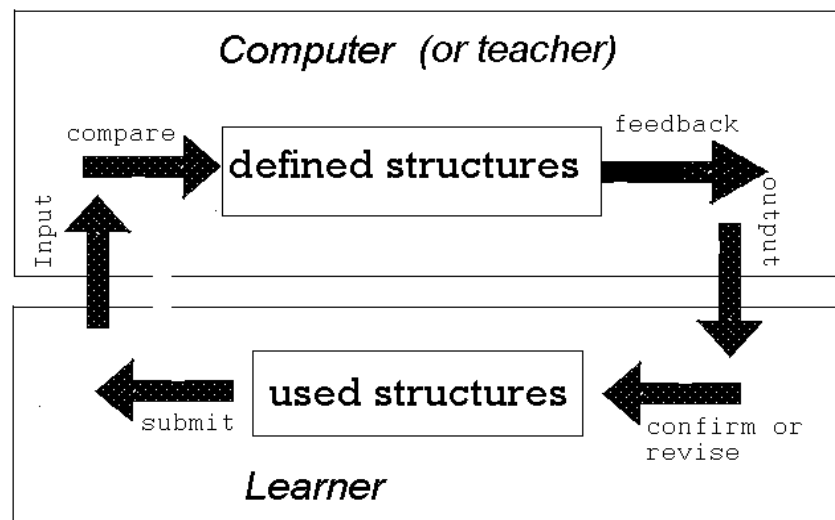
This understanding of feedback is usually associated with the notion of a servo system:

**servo system** an automatic control system used in aircraft, motor cars, and other complex machines. A specific input, such as moving a lever or joystick, causes a specific output, such as feeding current to an electric motor that moves, for example, the rudder of the aircraft. At the same time the position of the rudder is detected and fed back to the central control, so that small adjustments can continually be made to maintain the desired course. (Upshall, 1993, 892)

Of course, the term feedback is also frequently used in psychology and pedagogy in a surprisingly similar way. Annett (1969), in his book *Feedback and Human Behaviour*, claims that “the concept of feedback can be applied to the analysis of behavior ranging from simplest of movements to complex problem-solving tasks. ... The general term used since about the turn of the century for a variety of forms of psychological feedback is knowledge of results (KR).” (Annett, 1969, 26) He further explains that this kind of feedback is usually intrinsic. “When the experimenter adds an additional feedback loop this may be called extrinsic KR or *augmented feedback*. The most common example is the

addition of information regarding the standard of performance.” (Annett,1969, 27)

The feedback loop for giving extrinsic or augmented feedback in grammar learning is shown in figure 1.



**Figure 1:** Feedback loop in grammar learning.

The learner submits textual input to the computer. This input is constructed on the basis of the grammatical competence the learner has. The parser compares the used structures with the structures it can analyse with its computational grammar and generates feedback which is based on the results of this comparison. (A human teacher produces feedback on the basis of the comparison with his/her internalised grammar.) The learner has then the choice to confirm his/her structures or revise the submitted input in line with the feedback given. It is this place where the feedback loop for a (human) learner differs from a similar feedback loop for a technical device - a machine has no choice but to revise the input based on the feedback information.

Using this general understanding as the starting point, this article discusses different variables that influence the quality of feedback. The complex nature of feedback in language learning necessitates a multi-faceted approach to its description, design and implementation. Given that we are interested in the provision of help in a language learning situation and that the implementation of the feedback algorithm will be in a (parser-based) CALL application, the concept of feedback will be discussed from three different aspects:

- ① Psychology and Learning Theories
- ① Second Language Acquisition Theories
- ① Human-Computer Interface Design

A discussion of feedback from a linguistic perspective, which is an important fourth aspect, can be found in Schulze (1999).

## **Learning Psychology and Feedback**

Firstly, relevant findings of behaviorist psychology will be outlined. Behaviorist psychology provides the starting point of this excursion into learning psychology for two reasons: Firstly, behaviorist psychologists imposed strict rules for experiments they conducted, i.e. concentrating on observable stimuli and responses and avoiding any speculation about unobservable processes. These observations

were very often recorded by using quantitative measures. Results are therefore closely related to some mathematical understanding, which in turn is closer to the world of computing. And secondly, the concept of *reinforcement* is frequently used in behaviorist learning psychology and appears to be related to the concept of feedback under investigation here. The assumption is that feedback of a certain kind can act as a reinforcer.

Much of the research in learning psychology has been based on experiments with animals. Is reinforcement really a factor which has to be taken into consideration when talking about human behavior and in particular about learning? Lieberman argues in that context: "When reinforcement is used in accordance with all these principles, it can be substantially more powerful than our everyday experience might suggest." (Lieberman, 1990, 208) The principles to which he referred are the following:

1. The kind of reinforcer used is important. The Premack principle says that the strength of a reinforcer can be determined by observing how much time subjects dedicate to the reinforcer if it is freely available. For a learning context, we could ask: what efforts are learners prepared to undertake if they want to gain social recognition, improve their group status, be successful etc.
2. Under these conditions secondary reinforcers - reinforcers that satisfy no immediate basic need (e.g., grades, points, scores) - can be as powerful as primary ones if they are paired with a primary reinforcer examples of which were mentioned under 1.
3. "To generate a high rate of responding, which will persist even if reinforcement is not available for some period, partial reinforcement schedules are preferable to continuous reinforcement - especially variable ratio and interval schedules, in which the reinforced response cannot easily be predicted." (Lieberman, 1990, 207) In other words, reinforcement should not be used after each response, but only intermittently and certainly in fashion that is not transparent to the learner.
4. The quality of responding to a reinforcer depends on the motivation which in turn depends on how deprived the subject was of the reinforcer and on the incentive value of the reinforcer. "The Yerkes-Dodson law says that the optimum level of motivation for learning depends on the difficulty of the task. For simple tasks, high motivation is helpful; on more difficult tasks, strong motivation can narrow attention in a way that interferes with learning" (ibid.).
5. In order to achieve occurrence of response in a wide variety of situational settings, it has to be reinforced in a variety of settings. This, of course, coincides with the more general idea of applying a variety of methods (e.g. learning tasks, exercise types). If in each of these different learning situations certain behavioral traits are reinforced, the stimulus-response relationship is going to be more stable.
6. "When a response is difficult to learn, it may be possible to shape it first by first reinforcing a simpler response, and only gradually requiring closer approximations to the target behavior." (op.cit., 208)

If one considers the six principles listed above in the context of language learning and computer-assisted language learning in particular, then it is evident that reinforcement plays a role in these processes, if only due to recurring patterns in learning tasks and exercises, in praise and criticism. Of course, in modern teaching situations most of the reinforcers used are of a social nature – mainly in terms of social recognition of one kind or another - rather than a material one.

Consequently, we have to ask what role exactly does reinforcement play in learning theory? One

learning theorist frequently associated with early developments in CALL was Skinner. His position emphasized the effects of a response on the response itself. Skinner concluded that the effects of reinforcement and punishment are not symmetrical; that is, reinforcement changes the probability of a response's recurring, but punishment does not. As CALL practitioners and researchers know, his work led to the development of programmed learning and teaching machines. (c. Hergenhahn and Olson, 1997, 78)

Skinner, like Thorndike, was very interested in applying his theory of learning to the process of education. To Skinner, learning proceeds most effectively, if (1) the information to be learned is presented in small steps, (2) the learners are given *rapid feedback* concerning the accuracy of their learning (i.e. they are shown immediately after a learning experience whether they have learned the information correctly or incorrectly), and (3) the learners are able to learn at their own pace. (Hergenhahn and Olson, 1997, 105, my emphasis)

Of course, many arguments have been made since for and against programmed learning and behaviorist theories in general. It is striking, though, that reinforcement remained an important category in the discussion of learning.

For most behaviorists, reinforcement is a necessary condition for learning. ... In contrast, most cognitive theorists believe that learning occurs independently of reinforcement. For them, what reinforcement does is provide the organism with information that can act as an incentive to translate what has already been learned into behavior. (Hergenhahn and Olson, 1997, 450)

In any case, when designing a language learning tool, findings of learning psychology cannot be ignored for practical reasons. We can conclude from the many successful experiments cited in the literature on reinforcement (both Lieberman, 1990 and Hergenhahn and Olson, 1997 provide a good overview) that feedback can act as a powerful reinforcer. Knowledge of results, verbal praise, scores and such like do not only confirm or disconfirm the correctness of grammatical structures in the language learning process, but they also (at least potentially) reinforce certain behavioral patterns. Even if one constructs the worst-case scenario, and claims that reinforcement has no influence on language learning, then it is still an important factor to be considered when designing the program or tool because reinforcement can certainly influence the behavior towards the computer program, and thus indirectly influence the learning experience.

On the other hand, of course, there are some inherent problems with reinforcement that need to be considered and if possible avoided when it comes to providing feedback. Reinforcement should not be bribery because then the desired response would not be achieved in the absence of a reinforcer. The mildest reinforcer possible ought to be used. "If reinforcement is seen as a means of control for the benefit of the controller, then it is less likely to be effective." (Lieberman, 1990, 275) This is one of the differences between humans and animals reacting to reinforcers. Humans can act adversely when praised for responding exactly as the subject in charge of the reinforcer expected. Given the fact that in a computer-assisted language learning situation the incentives and thus the reinforcement is controlled by a machine, this adverse reaction to praising the learners for having done exactly as they have been told is most likely to be much stronger. The term bribery does not only refer to the use of excessive material reinforcers (e.g., large sums of money), but also to the inflationary use of (often one and the same) praise words such as 'excellent' and 'brilliant'. If these are given as feedback to all correct answers, as is the case in a number of CALL programs, then they soon lose their power as a reinforcer (see again the third principle listed above).

Similar caution is necessary when attempting to weaken an unwanted response, e.g., the application of an inappropriate grammatical rule. Negative reinforcement - punishment - was widely discussed in behaviorist literature. "Early research suggested that punishment had only a temporary effect on behavior, but more recently research has reversed this conclusion. When punishment is immediate, firm, accompanied by a clear (and fair) explanation, and when it occurs in a variety of settings, it can be a very powerful tool for eliminating undesirable behavior." (Lieberman, 1990, 243) However, the dangers are great. Punishment, already in its mildest form (e.g., negative comments) can result in the following:

- ⊗harmful side effects
- ⊗fear and/or anxiety which then inhibits attention
- ⊗tendency towards increased aggression (here the punishing subject is used as a model.)

Therefore, it appears to be best that no computer operation should be performed that can be perceived as punishment by the learner due to the potential side effects of negative reinforcement and its relatively unpredictable and low success rate. At first, this sounds fairly obvious, but if one considers the fact that a number of (language) learning packages offer feedback like 'Wrong!', 'Incorrect!', 'False' or simply 'No' and if one accepts that these short phrases can be perceived as mild social punishment, then it becomes clear that careful consideration must be given to the formulation of feedback messages on linguistic errors. The often negative side effects of punishment, can be seen in learning programs which sound a high-pitched tone if an error was made. To the embarrassment of the learner, this tone is heard right across the classroom. It does not take much to imagine what this kind of negative reinforcement does to the motivation of the learners and to their willingness to experiment with language.

It is not only in behaviorist approaches to learning that information on feedback can be found. In *information-processing psychology*, feedback is similarly defined as in servomechanisms - it forms a loop between the input and output of an action in that the output serves as information on the adequacy of the input. This information-processing approach to psychology can be subsumed under *cognitive psychology*. Tolman, a psychologist in the cognitive tradition who took his lead from the *Gestalt* theorists, argues that learning is not the learning of stimulus-response relationships as the behaviorists believe, but the discovery of what leads to what. He rejected the notion of reinforcement as unimportant, "but there is some similarity between what Tolman called confirmation and what the other behaviorists called reinforcement. During the development of a cognitive map, expectations are utilized by the organisms. ... Early tentative expectations are called *hypotheses*, and they are either confirmed by experience or not. Hypotheses that are confirmed are retained, and those that are not are abandoned." (Hergenhahn and Olson, 1997, 302)

In Bandura's theory, reinforcement has two major functions. First it creates an *expectation* in observers [see observational learning] that if they act like a model who has been seen being reinforced for certain activities, they will be reinforced also. Second, it acts as an *incentive* for translating learning into performance. (Hergenhahn and Olson, 1997, 334)

It can be seen from these short sketches of cognitive approaches to learning in general and feedback in particular that they might define reinforcement differently (or label it differently), but the concept remains an important one in the attempt to explain learning processes. The consideration of reinforcement in computer-assisted language learning is particularly important because repetition is inherent in many CALL programs and makes reinforcement of certain linguistic and non-linguistic behavioral traits more likely. Different learning theories can inform aspects of CALL design in that they highlight potential benefits and dangers of reinforcement, knowledge of results and feedback in general.

Strong criticism of the concept of reinforcement as an explanatory tool for language acquisition came from within linguistics. These criticisms have also shaped what is known today as second language acquisition theory.

## Second Language Acquisition Theories and Feedback

These behaviorist views have now been discredited. Chomsky's (1959) review of Skinner's *Verbal Behavior* set in motion a re-evaluation of many of the central claims. The dangers of extrapolating from laboratory studies of animal behavior to the language behavior of humans were pointed out. The terms 'stimulus' and 'response' were exposed as vacuous where language behavior was concerned. 'Analogy' could not account for the language user's ability to generate totally novel utterances. Furthermore, studies of children acquiring their L1 showed that parents rarely corrected their children's linguistic errors, thus casting doubt on the importance of 're-inforcement' in language learning ... These studies suggested that language acquisition was developmental in nature, driven as much, if not more, from the inside as from the outside. (Ellis, 1994, 300)

The application of Chomsky's hypothesis of an innate universal grammar to second language acquisition is still somewhat controversial (see e.g., Cook and Newson, 1996, 291ff). The exact influence of universal grammar (UG) on second language acquisition processes is viewed differently by different SLA researchers - UG is either seen as playing a major part, some part or no part at all in these processes. For a detailed discussion see (Cook and Newson, 1996, 101ff). However, there appears to be a consensus as to the existence of the language acquisition device, a cognitive faculty dedicated to the processes of language acquisition.

Of course, rejecting the idea that language acquisition can be explained solely in behaviorist terms does not mean that we can ignore stimulus-response relationships and reinforcement in language learning altogether. Current thinking about second language learning and acquisition is also still influenced by Krashen's hypotheses (1985) which also show the importance of other cognitive faculties apart from the language acquisition device. He assumes that learners have two systems for dealing with a second language: an *acquired* and a *learned* system. The former is the result of communication, the latter is the result of conscious attention to language and the learning of rules and items. Krashen's view that these two systems are not related has been heavily disputed and can now be seen as disproved. Long (1991), for example, has tested the hypothesis and has strongly argued in favor of a focus on form in language learning and teaching (For a more detailed discussion see (Schulze, 1998)). Long also argued for the effectiveness of certain kinds of feedback.

The widely accepted view that second language is acquired and learned entails that other cognitive faculties than the language acquisition device have to be used. In other words, independent of whether one presupposes the existence of a universal grammar and a language acquisition device, it is clear that other cognitive processes contribute to the learning and the acquisition of a foreign language - and more importantly, some of these processes could at least benefit from feedback and reinforcement. Thus, the role of neither feedback nor reinforcement should be ignored when design issues in computer-assisted language learning are considered.

Feedback in language learning is mainly done by treating linguistic errors.

A number of terms have been used to refer to the general area of error treatment; these are 'feedback', 'repair', and 'correction'. 'Feedback' serves as a general cover term for the information provided by listeners on the reception and comprehension of messages. As

Vigil and Oller (1976) have pointed out, it is useful to distinguish 'cognitive' and 'affective' feedback; the former relates to actual understanding while the latter concerns the motivational support that interlocutors provide each other with during an interaction. 'Repair' is a somewhat narrower term used by ethnomethodologists such as Schegloff, Jefferson, and Sacks (1977) to refer to attempts to identify and remedy communication problems, including those that derive from linguistic errors. 'Correction' has a narrower meaning still, referring to attempts to deal specifically with linguistic errors; it continues an attempt to supply 'negative evidence' ... in the form of feedback that draws the learners' attention to the errors they have made. (Ellis, 1994, 583f.)

With reference to cognitive feedback, Ellis (1994, 354) points out on the basis of a study by Vigil and Oller (1976) that positive cognitive feedback results in fossilization whereas negative feedback causes learners to work on their error. Here, positive cognitive feedback means the recipient signals that he or she understood the message independent of the number of errors. Negative feedback refers to a reply which says that the learner utterance has not been understood. Even more precise information on the nature of effective feedback is provided by Pica et al. who established that the main factor was the nature of the feedback signals (Ellis, 1994, 283). Lyster and Ranta (1997) came to a similar conclusion. Learners tended to rephrase their utterances upon clarification requests, but were less likely to rephrase after confirmation requests or repetitions. In other words, if errors trigger a clarification request which signals that what the learner said has not been understood, the learner is much more likely to work on the error. This can also be achieved by a computer program which simply indicates to the student that it could not fully process the input because there were errors in the text. Naturally, this can only be the 'trigger-message' which causes the student to reconsider his or her input. Further help needs to be given in order for them to be able to correct the error.

It has to be mentioned at this stage that the pointing out of linguistic errors to foreign-language learners has been subject of some controversy mainly over whether the provision of negative evidence is necessary or helpful for L2 development (Mitchell and Myles, 1998, 16). The problem here is that very little evidence has been found, which would confirm the effectiveness of telling the language learner that a sentence or phrase is not acceptable according to the norms of the target language. However, there are some areas for which negative feedback has been confirmed as effective. Mitchell and Myles (1998, 141) summarize the achievements of interactionist research regarding feedback by stating that learners who received negative feedback can have an advantage when later tested on those structures. Long (1996, 414) confirms that negative feedback can facilitate language learning at least for vocabulary, morphology and language-specific syntax. Error feedback has also received some attention in the discussion on the hypothesis of comprehensible output (Swain, 1985; Ellis, 1994, 282).

Based on research in second language acquisition, more and more CALL programs place emphasis on providing learners with the opportunity to test hypotheses in comprehensible output, on the negotiation of meaning through providing cognitive feedback, and of course, on the important role of error feedback in general.

Having explored selected concepts of feedback in second language acquisition theory, we will now turn to the last area to be investigated - that of human-computer interaction.

### **Human-Computer Interaction and Feedback**

Human-computer interaction (HCI) as an area of research that deals with questions of interface and dialog design. It is only the latter that will concern us here. In other words, the two questions for this section are:

- ⑩ What are the characteristics of human-computer interaction by comparison to human-human interaction?
- ⑩ Which findings of HCI research are applicable to the provision of feedback by a grammar program for foreign-language learners?

The differences between humans and machines have obviously to be taken into consideration in order to understand the interaction of learners with CALL programs:

- ⑩ Machines are compiled out of individual parts for a very specific purpose; whereas humans are holistic entities whose parts can be differentiated.
- ⑩ Humans process all sorts of experiences and repeatedly and interactively create their own environment - something machines cannot do. They 'calculate' a problem on the basis of pre-wired rules.
- ⑩ The main features of human thoughts is their inherent contradictions and the ability to cope with them - something that will not be computable due to its complexity, variety and degree of detail.

(Schmitz, 1992, 209f.)

Schmitz by no means attempts to diminish the capabilities of computers. He claims that computers can theoretically carry out all operations, but never actions because they do not recognize aims, purpose, position of the action. The differences between humans and machines can for our purposes, i.e. the theoretical description of human-computer interaction, be legitimately reduced to the distinction between actions and operations as is done in Activity Theory. The proponents of Activity Theory, e.g., A N and A A Leontiev and L S Vygotsky, view humans very much as social beings whose psyche is developed in activity, i.e. mainly in social interaction and in actions within an environment. The main categories used are *activity*, *action* and *operation*:

If activity may be correlated to motive and action to aim, then operation may be correlated to conditions. This simplest psychological unit of activity is subordinate to action, and therefore in turn to activity as a whole. ... The correlation between activity, actions, and operations is dynamic. Operations can at first be directed towards a conscious aim, i.e. be actions; they then become automatic and vanish from man's consciousness. There is, however, another type of operation, which emerges as the result of unconscious adaptation and probing for the right way to act. (Leontiev, 1981, 17f.)

Communicative activities can be divided into actions which are intentional, i.e. goal-driven; and these can be sub-divided into operations which are condition-triggered. These operations are normally learnt as actions. This is best illustrated with an example: gear-switching when driving a car. The learner-driver is asked by the driving instructor to change gear and this becomes the goal of the learner. Once the learner-driver has performed this action a sufficient number of times, this action becomes more and more automated and in the process loses more and more of its intentionality. A proficient driver might have the goal to accelerate the car which will necessitate switching into higher gear, but this is now triggered by a condition (the difference between engine speed and speed of the car). It can thus be argued that humans learn to perform complex actions by learning to perform certain operations in a certain order. Machines, on the other hand, are only made to perform certain (sometimes rather complex) operations. Sequences of such operations can be performed by sophisticated machines like computers in rapid succession (or with powerful computers even in parallel), but each and every one of them is initialized by a condition (e.g., a mouse-click, keyboard input) and they are not subordinated to an intention, so they cannot be described as actions (Schmitz, 1992, 169).

This has some bearing on our understanding of the human-computer interaction that takes place when a

learner uses language learning software. When, for instance, the spell checker is started in a word-processing package, the software does certainly not have the intention to proof-read the learner's document. The computer just responds to the clicking of the spellchecker menu item and performs the operation of comparing the strings in the document against the entries in a machine dictionary. The result of the comparison triggers the next operation: if an identical string has been found in the dictionary, the next string from the document is compared; if an identical string could not be found in the dictionary similar strings will be selected from the dictionary according to an established algorithm and these will be displayed to the user as spelling alternatives. For the computer user (in our case a learner), it might look like the computer is proof-reading the document - one only realizes that no 'proper' document-checking is going on if a correctly spelled word is not found in the dictionary or nonsense alternatives are given for a simple spelling error.

Let us compare this interaction with an interaction between two people. Person X interacts with Person Y in that he observes Person Y's action, reasons about the likely intention for that action and reacts according to this assumed intention. It appears to be the case that many learners transfer this approach to the interaction with a computer in a language learning situation, i.e. they interpret the sequence of operations performed by the computer as an action, reason about the 'intention' of the computer and react accordingly. This, for example, explains why many learners when an answer they believe to be right is rejected by the computer get just as frustrated as they would get if it were rejected by their tutor. Of course, an ideal computer-assisted language learning system would avoid such pitfalls and not reject a correct response or overlook an incorrect one. Since any existing system can only approximate this ideal, researchers and developers in CALL can only attempt to build systems that are capable of performing complexly structured sequences of (linguistic) operations so that learners can interact meaningfully and successfully with the computer.

This conclusion takes us to the second question posed above: Which findings of HCI research are applicable to the provision of feedback by a grammar checker for foreign-language learners? It has already been said that the main focus here is on the dialog aspect of human-computer interaction (HCI). O'Shea and Self (1983, 115) emphasize the importance of implementing a "dialog system" in any Intelligent Tutoring System (ITS). Sutcliffe (1995, 165f) discusses principles of dialog design from the perspective of HCI. As the first criterion he uses the term 'feedback' with which he means that the computer user is continuously informed about what is going on. With regard to error messages in general, Shneiderman (1992, 305ff.) outlines the following principles:

- ⑩specificity
- ⑩constructive guidance and positive tone
- ⑩user-centered phrasing
- ⑩appropriate physical format

It has to be noted that with user-centered phrasing Shneiderman argues against the use of anthropomorphic instructions (Shneiderman, 1992, 312f.) because the pretense that the computer is a 'human' cannot be sustained for a long period of time, and will not be appreciated by (adult) computer users. It can be safely assumed that these principles for error messages in general can and must also be applied to messages that relate to errors the learner made in producing a foreign-language text. This is so because both kinds of messages (for computer users as well as for language learners) are generated by a computer program. When discussing features of intelligent help systems, Sutcliffe (1995, 256ff) outlines the following components: dialog manager, user model, diagnostic module (lexical, syntactic, semantic) and a remediation-repair planner. It is apparent how similar this catalog of desiderata is to one for an intelligent tutoring system.

HCI research also provides some answers concerning the timing of feedback: Only one problem at a time should be presented to the user. "Novices to tasks exhibit better performance and prefer to work at slower speeds than knowledgeable frequent users." (Shneiderman, 1992, 256ff) Short response times are quick and enjoyable, longer response times motivate the users to exercise more care and make fewer errors. Shneiderman reports from an experiment: "Overall, subjects working at the shorter response time completed their lessons more quickly and had a favorable attitude toward the system. There were clear indications that subjects tried to work more carefully and made fewer errors with the longer response time." (Shneiderman, 1992, 290)

## Conclusion

If one subscribes to the opinion that error correction is a worthwhile activity in the language learning process, then both the error diagnosis process and the provision of feedback ought to be based on a sound theoretical understanding. This article showed how selected information from Second Language Acquisition Theory, Learning Psychology and Human Computer Interaction Research can be utilized by designers of CALL software. Of particular importance are

- ⊗ a concise and adequate description of errors
- ⊗ the consideration of issues like reinforcement, which is going to be particularly strong in exercises with repeated elements, and the dangers associated with feedback that can be perceived as social punishment,
- ⊗ a good understanding of second language acquisition processes, e.g. the advantage of negative cognitive feedback, and the general role of corrective feedback in language learning,
- ⊗ a careful consideration of the traits of human computer interaction.

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Mathias Schulze's research focus is the application of linguistic theory to CALL. He has published on language technology in CALL and the acquisition of grammar through CALL. Currently, he is working on the computational implementation of German grammar, computerized adaptive language testing and the online teaching and learning of German.

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