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December 2003

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Recommended Citation

Lin, Ming; Crews, Janna; Cao, Jinwei; Nunamaker, Jr., Jay; and Burgoon, Judee, "AGENT99 Trainer: Designing a Web-Based Multimedia Training System for Deception Detection Knowledge Transfer" (2003). *AMCIS 2003 Proceedings*. 334.
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AGENT99 TRAINER: DESIGNING A WEB-BASED MULTIMEDIA TRAINING SYSTEM FOR DECEPTION DETECTION KNOWLEDGE TRANSFER

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Abstract

Although detection of malicious deception is important to prevention of possible harm to individuals or organizations, human deception detection accuracy is poor (around 40%-60%) because people lack deception detection knowledge. Therefore it is important to create strategies and tools for making effective transfer of deception detection knowledge readily available to the masses. This paper describes our research efforts to design and implement a Web-based multimedia training system, Agent99 Trainer, to provide effective deception detection knowledge transfer. Agent99 Trainer captures experts' knowledge on multimedia, presents it to learners through an integrated interface, provides practice opportunities by allowing viewing of real life examples, and gives immediate and elaborate feedback. Furthermore all the components of Agent99 Trainer are integrated together to achieve the best possible performance. Our initial experiment shows that training using Agent99 Trainer improves human deception detection accuracy and that the training is as effective as lecture-based training. In addition, our usability study shows that Agent99 Trainer is easy to use and supports the system design from a subjective perspective.

Keywords: Knowledge transfer, deception detection, deception detection training, Web-based training, multimedia

Introduction

Deception, defined as “a message knowingly transmitted with the *intent* to foster false belief or conclusions” (Buller & Burgoon, 1996, p.205), is a serious threat to security. Undetected deception can be very dangerous on the battlefield or in business competition. However, deception detection research studies (DePaulo & Pfeifer, 1986; Kraut, 1980; Miller & Stiff, 1993) indicated that humans generally are not good at detecting deception, reporting detection accuracy rates in the range of 40%-60%. One of the primary reasons for so little deception detection accuracy is that people have too little knowledge of deception or operate on the basis of unreliable knowledge, such as erroneous cues or cognitive biases (Kalbfleisch, 1992; Vrij, 2000). Recent

research has revealed more reliable information about the nature of deception and cues of deception (Zuckerman et al., 1981; DePaulo, 2001), but relatively few experts have the skills for deception detection. Development of strategies and tools to help manage and transfer expert knowledge to people is critical for improving people's ability to detect deception. Although training is a powerful tool for transferring knowledge, its effectiveness is strongly linked to the way in which it is designed and implemented. All previous deception detection training has taken an instructor-led, lecture-based form (DeTurck et al., 1990, 1991; Fiedler & Walka, 1993; Vrij, 1994).

The major disadvantage of instructor-led, lecture-based training is that a great scarcity of expert instructors severely limits availability of this type of training. Web-based training can overcome this disadvantage because it allows unlimited access to knowledge, without time and/or geographic constraints. A Web-based training system therefore provides a possible approach to effective knowledge transfer. Because the design and implementation of a Web-based training system is critical to the effectiveness of training, so there come the questions: what are the special requirements of deception detection training; And what is the best design and implementation of the Web-based training system in order to fulfill those requirements?

To answer this question, we first identify an effective format for deception detection training, suitable learning theories and their implications for our instructional design, and the important design features in the *Related Research* section. Based on that, the *System Design and Implementation* section describe how we designed and implemented a Web-based training system called Agent99 Trainer to accomplish deception detection knowledge transfer through explicit instruction, practice and immediate feedback. Then, we conducted an experiment and usability study to evaluate Agent99 Trainer's performance as we have described in the *Evaluation* section. Finally we discuss the contributions of our work and some possible directions for future research in the *Discussion and Future Directions* section.

Related Research

In this section, we talk from a theoretical perspective about how related research guided the design of Agent99 Trainer and identify what features we wanted to use to guide our system design. In the next section, *System Design and Implementation*, we discuss how we incorporated those features into the final design and implementation of the system.

Deception Detection Training

Research on deception detection training shows that accuracy of deception detection can be improved using "practice" and "self-taught" strategies, in which the researchers either ask observers to evaluate the veracity of communication after having viewed deceivers' normal communications or direct observers to judge communication veracity after having received immediate feedback on their judgments (Brandt et al., 1980a, 1980b; Zuckerman et al., 1984). To generalize these strategies and avoid developing false cues, the researchers incorporated explicit training of generalizable and reliable deception cues into the training programs (DeTurck et al., 1990, 1991; Fiedler & Walka, 1993; Vrij, 1994). Based on existing research, we found that effective training for deception detection should have three critical components: explicit instructions on cues of deception, practice evaluating the veracity of real communications, and immediate outcome feedback on judgments that have been made (DeTurck et al., 1990, 1991; Fiedler & Walka, 1993; Vrij, 1994). Researchers also have indicated that, to achieve better training performance, explicit instructions should be associated with practice followed by immediate feedback (Vrij, 1994). In addition, the length of training is another basic criterion for deception detection training, which requires repeated sessions of no less than 60 minutes (Frank & Feeley, 2002). As a result, we conclude that well-designed deception detection training must effectively integrate the three critical components of *explicit instruction, practice and feedback* and provide adequate training time. Next we will discuss underlying learning theories and their implications for our design and implementation of such a training system incorporating these three components and allowing unlimited training access.

Constructivism and Web-Based Training

Various learning theories and associated instructional design could be used to deliver the three components of deception detection training. We believe that constructivism is the most suitable one for an ill-defined problem such as deception detection. Constructivists emphasize that knowledge is constructed from learners' actively participating in its creation instead of passively receiving information or instruction (Phillips, 1995). The process of knowledge construction or learning can be explained in terms of constructing a model based on personal experience and problem interpretation (Merrill, 1991). Constructivism is well suited

to dealing with ill-defined problems (Ertmer & Newby, 1993) such as deception detection, in which no unfailing sets of deception cues are available and deep understanding of cues requires extensive experience and high levels of cognitive processing (Levine et al., 1999; Zuckerman, 1984). However, because constructivism promotes personalized learning experience and each individual is responsible for constructing her/his own knowledge, designing a common instructional format becomes a great challenge. Jonassen (1991) has suggested that purposeful knowledge construction can be facilitated by learning environments which 1) provide multiple representation of reality, 2) provide real-world, case-based learning rather than pre-determined instructional sequences, 3) foster reflective practice, and 4) enable context- and content-dependent knowledge construction.

Web-based training contributes to the facilitation of constructing such a learning environment. The use of hyperlinks in a Web-based training environment permits working with undetermined instruction sequences. Hypermedia, as an application of multimedia, provides the possibility of multiple representation of reality and rich representation of the real world. In addition, Web-based training solves the problem of lengthy training time requirement by providing unlimited access to learning materials anytime and anywhere. Web-based course and training has been shown to be "at least as effective as traditional lecture" (Wade, 1998). Although Web-based training technology provides a platform for building a suitable learning environment in which to deliver the three components of deception detection training, we still needed to determine how those components would be supported. For instance, we needed to decide how to represent an explicit instruction, to provide examples for practice, and to present feedback (e.g. in what media) and integrate them all in a Web-based training environment.

Integrated Multimedia

Humans obtain and process new information through sensory perceptions (James & Galbraith, 1985). Research has identified three primary perceptual modalities of learning: visual (by seeing), aural (by hearing), and kinesthetic (by doing) (Wislock, 1993) and has indicated that a well-designed training program should present materials using a multi-sensory approach with visual, aural and kinesthetic information (Wislock, 1993) to meet the needs of different learners. The multi-sensory approach also is accepted as the natural way of learning in traditional classroom training, in which the learners can watch presentation, listen to instructor, and solve problem at the same time. A Web-based training environment provides a way to implement this approach by using multimedia technologies, e.g., putting video, audio, image, and/or animations in one Web interface. In addition, recent research has shown that the effectiveness of learning could be further improved by synchronizing the online learning materials in the Web-based training environment.

Effects of Cases and Feedback

Traditional lecture-based training often provides narrative instruction directed toward reaching some predetermined learning outcomes by sequenced instructions. In contrast, case-based training gives the learner descriptions of realistic scenarios and lets the learner assess situations and react appropriately. Case-based learning facilitates building a constructivist learning environment (Jonassen, 1991) by providing real world cases and enabling context- and content-dependent knowledge construction. Hypermedia (as an application of multimedia) and hyperlinks in a Web-based training system provide a good way to implement case-based training by providing video, audio and other multimedia cases that simulate the real world and allowing learners to take full control over the learning process through nonlinear access to information (Semrau et al., 2001). However, Jonassen (1991) also has indicated that each phase of knowledge acquisition requires a different type of learning: 1) initial knowledge acquisition is best served by classical instruction, and 2) the case-based, constructivist learning environment is more suited to the second phase of knowledge acquisition. Therefore, instructional design combining traditional training (e.g., a lecture) with case-based training may be most beneficial for learners (Davidson, 1998), confirming our conclusion drawn from reviewing the deception detection training literature: that a combination of explicit instruction and practice produces better training effects.

Besides the practice implemented by case-base learning, feedback is also very important in the constructive learning process because it facilitates learner evaluation and modifies their mental models (Anderson et al., 1977; Guskey, 1997). Moreover, in a case-based learning environment, internal and external feedback guides the learner's interpretation of realities, and encourages him/her to refine or revamp a mental mode. Without external feedback a learner might form a wrong mental modal from self-reflection (Marakas, 1995). Ultimately, Guskey (1997) has emphasized that the best feedback to students is immediate, specific, and direct directions for improvement. Specifically, in deception detection training, feedback should point out which cues are responsible for the veracity judgment of a case or an example (Frank&Feeley, 2002).

Based on the above literature review and analysis, we believe what is needed is a Web-based multimedia training system that provides an integrated learning environment with synchronized multimedia learning materials, flexible control over the sequence of instructions, and access to multimedia cases that simulate reality, as well as immediate and elaborated feedback. The next section describes in detail the design and implementation of such a training system called AGENT99 Trainer.

System Design and Implementation

In this section, we focus on the system design and implementation of Agent99 Trainer that was built on our previous Web-based multimedia training system called LBA (Learning By Asking) (Zhang, 2002). LBA includes “integrated multimedia” and “virtual lecture” (called *Watch Lecture* in LBA) capabilities and provides the basic infrastructure for deception detection training as a general training tool. In order to satisfy the special requirements of deception detection training, we enhanced the architecture of LBA, changed the *Watch Lecture* component, added a *View Examples* component for deception detection practice and feedback, and most importantly seamlessly integrated the two components together to facilitate better deception detection training.

Overall System Architecture

The current system architecture of Agent99 Trainer is depicted in Figure 1. It is based on a three-layer client/server architecture, which includes client layer, application layer and database layer.

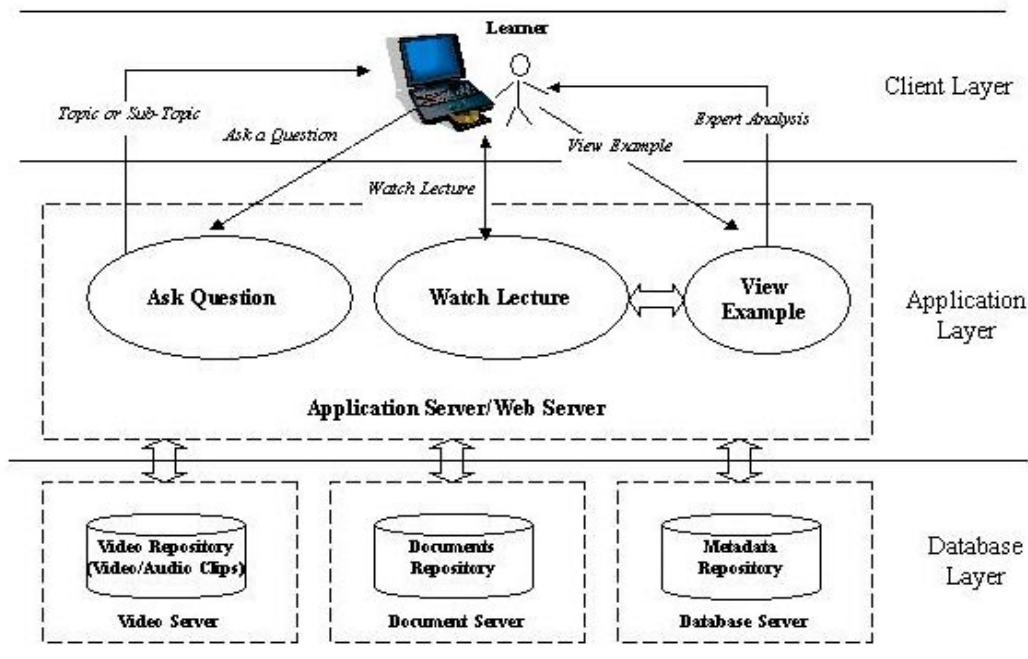


Figure 1. Agent 99 Trainer Architecture

- Client Layer: Learners access the AGENT99 learning environment through a Web browser. The client side is platform-independent, and requires only a web-browser, a video player and a sound card.
- Application Layer: The application layer includes an application server and a Web server. The application server holds the three major modules: 1) *Watch Lecture* allows learners to watch a lecture similar as if in a traditional classroom, each lecture is divided into topics and sub-topics, 2) *View Example* provides real-life examples and expert analysis to enforce the learning of concepts and theories in the lecture, and 3) *Ask Question* allows learners to ask a question using natural language, and the system returns a list of answers to the question (a list of video clips).

- Database Layer: The Database layer includes a video streaming server, a document server and a database server. The video server stores video and audio clips and provides video and audio streaming service. The document server stores other types of documents, such as images, text files, PDF files and Word files. The database server stores all the metadata of the video clips, lectures, topics, transcripts, and examples. For example, the length and description information of each video clip are stored in the database. In order to facilitate the content-based video retrieval in the *Ask Question* module, all the video clips are indexed based on the transcripts translated from the audio track in the video (Zhang, 2002).

The three system modules (*Watch Lecture*, *View Examples* and *Ask Question*) of Agent99 Trainer were designed and implemented as described below.

Detailed Description of Modules

Watch Lecture

The *Watch Lecture* module provides explicit instructions on deception cues by capturing expert lectures on digital media. In order to provide multiple representations of reality (Jonassen, 1991), we use the combination of instructor’s video, slides and transcripts of videos to form a “virtual lecture”, which simulates a real lecture in a traditional classroom training. All the learning materials in various media types (video, slides, and transcripts) are well structured and presented in a Web interface (Figure 2). Seeing that an advantage of traditional classroom training is that it supports diverse activities and rich media *simultaneously* and provides an interactive and rich learning environment (Hughes 1998), the *Watch Lecture* module simulates a traditional classroom-learning environment by synchronizing the three cells of instructor’s video, slides and transcripts (Figure 2). In the *Watch Lecture* module, each lecture (a lengthy video) is divided into topics and sub-topics (smaller clips). Navigation buttons and an outline of topics (implemented as a topics drop down menu) are provided so that learners can easily select any topic or subtopic in the lecture at any time. This provides a non-linear format for instructions and allows learners to control their learning processes.



Figure 2. *Watch Lecture* module

A unique feature specifically designed for deception detection training is the association of the deception examples with the topics in the lecture in order to combine the explicit instruction and practice. Practice is implemented in the *View Example* module to be discussed next). This association is implemented in two ways: 1) when the lecture (instructor’s video) goes from one topic to the next one, links to the *View Example* module are provided so that learners can go directly to viewing the deception examples

related to the current topic, and 2) an “Examples” drop-down menu allows learners to select any example to view while they are watching the lecture.

View Examples and Expert Analysis

Besides the “explicit instruction” implemented in the *Watch Lecture* module, the other two critical components of deception detection training, “practice” and “feedback”, are implemented in the *View Examples* module (Figure 3). The *View Examples* module in AGENT99 Trainer is designed to provide various types of real-life examples, scenarios and expert analysis that allow learners to practice and receive immediate and elaborated feedback. When viewing an example, the system allows learners to select different media tracks (audio, video, or text) and thus focus on cues in different communication channels (vocal, visual, or verbal). For instance, the learner may choose to listen to audio without video in order to focus on the vocal cues in deception (e.g. pitch increase) and avoid the distraction of visual cues (e.g., rigid posture). Furthermore, the *View Example* module is designed to provide learners with opportunities for reflection, which is critical for a training environment (Barab & Duffy, 2000). Reflection is designed and implemented as follows: an example is displayed to learners without expert analysis for a pre-coded “attention span” interval (e.g., a time period of 20 seconds) that forces the trainee to think about the example for a while, and then the system will prompt and permit the learners to view the expert analysis.

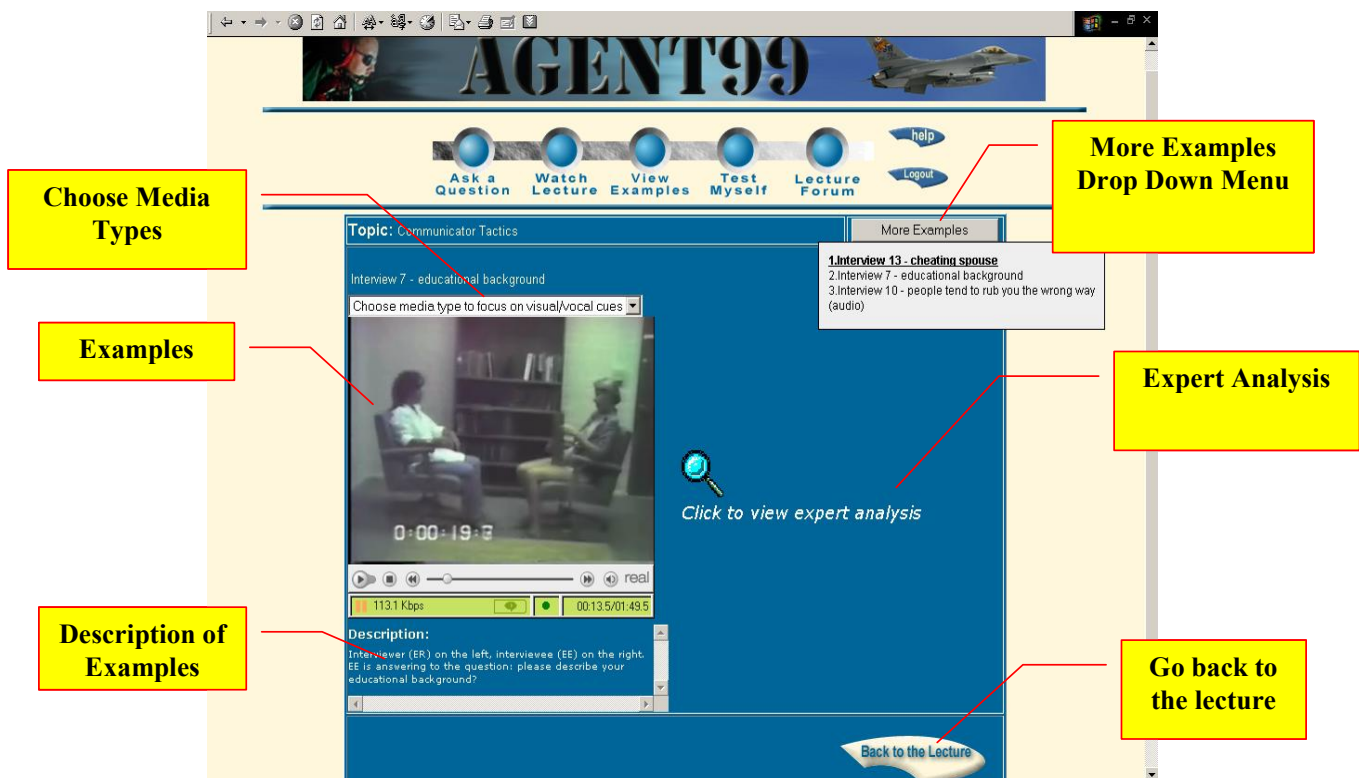


Figure 3. *View Examples* Module

The expert analysis informs the learner not only of the veracity of the example but also points out the cues used to make the judgment, thereby supporting the learner’s refinement of her or his own mental model. In addition, having the example and the expert analysis parallel to each other in one interface (see Figure 3) allows learners to review and reflect on the example in view of the expert analysis. Overall, this design provides repeatable opportunities for learners to think and reflect before and after viewing the analysis.

Ask Question

The *Ask Question* module in Agent99 Trainer is the same as what in the LBA system except for new deception detection data and new indices. The *Ask Question* module allows trainees to use natural language to ask a question regarding deception detection. After analyzing the question and searching in the database, the system will return a list of video clips (topics or sub-topics) ranked by their relevance to the question. The returned video clips are presented with associated slides and transcripts in an interface similar to that in the *Watch Lecture* module. The *Ask Question* module enables learning-on-demand by allowing the learner to search for knowledge of deception detection within the lectures. We use a natural language processing (NLP) based two-phase approach for video indexing and retrieval in the *Ask Question* module (Zhang, 2002). However, the *Ask Question* module is not used in the evaluation discussed in next section.

Evaluation

We evaluated our system design and implementation from two perspectives: effectiveness of Agent99 Trainer on improving detection accuracy, especially compared to lecture-based form training using an experiment, and user satisfaction of system design using usability study.

Experiment and Usability Test

To test whether the system improves deception detection accuracy and whether the performance of Web-based training system was better than performance under lecture-based training. We conducted an experiment at Research 1 University in the Southwest. The experiment was a pretest and posttest comparison between two treatment groups: Lecture group and Agent99 group. We found that training using Agent99 Trainer significantly improved the post-test detection accuracy (pretest mean: .4222, posttest mean: .6889, p-Value < .001). We also found that the detection accuracy in Agent99 group (pretest mean: .4222, posttest mean: .6889) was slightly better than that of the lecture group (pretest mean: .4405, posttest mean: .6429), but not significant. Refer to (Cao, et. al, 2003) for more details.

Furthermore, to test the subjective effectiveness of Agent99 Trainer, we conducted usability studies along with our experiment using a questionnaire. The participants filled out the questionnaire after the posttest judgment test, and only the subjects in the Agent99 group were asked to answer questions related to the usability test. In the questionnaire, we use a 7-points Likert scale to assess learners' satisfaction level on Agent99 Trainer (1 = Completely Agree; 2 = Mostly Agree; ... 7 = Completely Disagree). The results are shown below (Table 1).

Table 1. Participants Responses in the Usability Test (Questionnaire)

Questions	Mean
1. The overall training content is interesting to me.	2.33
2. The video/audio quality of the lecture is satisfactory.	2.83
3. It is easy to learn how to use the system.	1.83
4. During the learning process, I think that accessing of various parts of the system or navigating through the system is easy.	2.33
5. The structured and synchronized multimedia content provides aid in my understanding of the subject matter.	2.11
6. I enjoy the self-paced control I have in the selection of what I want to access in the learning process (be capable of watching any part of the lecture and any example at any time).	1.78
7. The View Example and Expert Analysis module helps me better understand the content of the lecture.	1.67
8. The knowledge I learn from the lecture(s) helps me analyze the examples I view.	1.65
9. Completing the training make me feel more confident in my ability to accurately detect deception.	2.28
10. I am enthusiastic/genuinely interested in utilizing this format of learning again.	2.41

The results were highly positive, justifying our system design from a subjective view. The numbers indicate that the Agent99 Trainer system was easy to use (question 1, mean was 1.83, between completely agree and mostly agree), the structure and synchronization of multimedia contents and self-based learner control was helpful (question 5 and 6), and more importantly the method of “view examples with expert analysis” and the association of explicit instructions (lecture) with practice (examples) helped the learning of deception detection (question 7 and 8).

Discussion and Future Directions

In determining how to effectively transfer deception detection knowledge, we identified the three critical components of deception detection: explicit instruction, practice and feedback. Guided by deception detection training research and learning theories, we designed and implemented a Web-based multimedia training system. Our experimental findings proved the effectiveness of the system in improving deception detection accuracy and that the system is at least as effective as a lecture-based training; and our usability test results further supported the appropriateness of our design from a subjective view. One of our future directions is to further test the design of the system by investigating the effects of different functionalities. In order to compare the learning effects obtained from different functionalities and our specific design, we plan to ask different groups of students to use different system functionalities (e.g. a *Watch Lecture* group and a *Watch Lecture + View Examples* group) and compare the training effects in a controlled experiment. We also plan to add another module called *TestMyself*, which will allow learners to test their own deception detection ability online. We also intend to use adaptive feedback (individual-learner oriented feedback) in *TestMyself*. The adaptive feedback should point out missing cues in a judgment question and reveal possible bias for each individual learner according to her/his test result in *TestMyself* and learning history.

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