ABSTRACT
This article reports on a user study conducted to assess the credibility of a humanoid robot. The study set-up was based on the “Monty Hall Problem”. Overall 13 people between the ages of 19 and 84 took part in the study (7 male and 6 female). The experiment was set up as a card-game where the participant had to guess which of the three cards shows a price. At one point of the experiment the robot advised the participant to change his/her mind and choose another card. During the user study the participants had to fill in a questionnaire on their level of certainty about their choice and the credibility of the robot. The results showed a significant correlation between the believability of the robot and the certainty in the decision made. Furthermore, the outcomes showed differences between participants who followed the robot’s advise and participants who did not, regarding credibility, certainty of the decision made and the estimation whether the robot was helpful or not.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation]: User Interfaces - evaluation/ methodology; I.2.9 [Artificial Intelligence]: Robotics

General Terms
Reliability, Experimentation, Human Factors, Verification

Keywords
User Study, Credibility, Monty Hall Problem, Uncertain Knowledge

1. INTRODUCTION
A goal of many user studies in Human-Robot Interaction is to evaluate the credibility of a robot. Consider a scenario where a service robot should give an advice to a human e.g. in a collaborative working environment or an elderly care setting: Which cues could be used to inform the design of the robot to support its credibility? Which factors cause an increased or decreased credibility respectively? A small preliminary user study will be presented in this article, which was conducted to gain first insights to the question of if the advise of a robot positively influences the decision process of the participant. In the following a short overview will be given on related research in the area of credibility of robots and conversational agents. Then the theoretical basis of the user study, its set-up and procedure will be described. Finally, the results of the user study will be discussed and an outlook on future work will be presented.

2. RELATED WORK
One of the first and most famous experiments addressing credibility and persuasiveness of a virtual agent was the ELIZA experiment, showing that participants can be convinced to talk to a human, not to a machine and even appreciate the conversation [9]. However, in the ELIZA experiments the participants did not know that they are actually talking to a machine. More recent studies confronted participants with questions regarding the believability and trustworthiness of screen characters as well as fully embodied robots (see e.g. [1];[7]). Using the McCroskey’s credibility scale, Shinozawa et al. [8] for instance could show that a 3D model of a robotic agent was rated higher in terms of source credibility than a 2D on-screen agent. Powers and Kiesler [6] conducted a study with four robot heads, each of which had a different shape. In the experiment the robots gave the participants online advices about their health. The outcome of the experiment was that the advices or recommendations of a baby face robot were more followed by the people. The robot’s voice and physiognomy changed the people’s perception of the robot’s human likeness, knowledge and sociability.

3. USER STUDY
The goal of the user study was to get preliminary insights to the question of if the advise of a robot influences the decision process of the participant positively. The theoretical basis for the study was the so-called Monty Hall Problem which will be explained in the following.

3.1 Theoretical Basis
The “Monty Hall Problem” (also sometimes called “Three Door Problem” or “Car-goat Problem”) forms the theoretical basis of the underlying study. The original name of the problem goes back to the American quiz show “Let’s make a deal” moderated by Monty Hall. The problem describes a paradox which is not solved by a lot of people at first. In the show the candidate had the possibility to win a car. Therefore he/ she had to choose one from three different given doors, in one of which the proposed car was hidden. From the two left doors the show master showed him/ her always the door with the goat. After that the candidate got another chance to think about his/ her decision and maybe to take the other left door. The question is, is it beneficial to choose the other door? Yes, it is. Because if he/ she changes the door, his/ her chance to win is twice as high (2/3) as if keeping his/ her first decision (1/3 chance). This kind of probability puzzle problem can be used to explore how to deal with uncertainty [3]. Actually only a few people realize this logic and the majority takes their first decision intuitively into account and keeps it. Even people with extensive statistical skills can struggle [5].
study described in the following was inspired by Komatsu et al. [2], where people estimated the robot’s abilities by acquiring how accurately the robot can detect a gold coin under three mountains in an imaginary video game.

3.2 Study Set-up
The study was set up as a game participants should play together with the human-like robot RS Media see figure 1. The experiment was conducted with two conditions:

(1) The robot is only talking, but not moving
(2) The robot is talking and moving

Each experiment consisted of three rounds of the game. The participant was told to choose the card with the Ace out of three possibilities.

Figure 1: The Setting
At the beginning of the game, the participant had to choose that one of the three given cards where he/she supposes the Ace, and was asked how secure he/she felt about that decision. Then the experimenter took a look below the other two cards, lays a blank card open and asks again how secure the participants felt about his/her choice. Now, the robot entered the game. The experimenter asked the robot, where it supposed the Ace. Then the robot answered: “I would choose the other card”. At this point the test person was asked if he/she wanted to change his/her choice. In the end the experimenter disclosed the secret and explained the Monty Hall Problem. The whole user study was accompanied by a questionnaire containing questions on the level of certainty of the choice (which had to be rated on a scale from 0 until 100 % certainty) and the credibility of the robot. Additionally the experimenter categorized the reason(s) for changing the decision.

3.3 Research Questions
The main research questions for the user study were:

(1) Which factors influence the credibility of a robot?
(2) Do people take advice from the RS Media robot?

Based on these research questions the following hypotheses were supposed:

H1: There is an increase in credibility if the robot is right;
H2: The condition (robot moving/ not moving) influences the certainty of the participant’s decision.

4. RESULTS
13 participants took part in the study, 7 male and 6 female at the age of 19 to 84. The participants had no previous experiences with (toy)robots and 8 out of 13 participants did not know the Monty Hall Problem. The results of the experiment confirmed hypothesis H1. At the end of the experiment the results showed a significant correlation between the credibility of the robot and the certainty of the participant’s decision. There was a positive correlation between the two variables, r = 0.64, p = 0.008. Furthermore, there were differences between participants who followed the robot’s advise (mean1) and participants who did not (mean2) regarding the final credibility (mean1: 60; mean2: 8.3), certainty of the decision (mean1: 65.5, mean2: 83.34) and the estimation whether the robot was helpful or not (mean1: 35; mean2: 6.7). H2 could not be confirmed as there was no significant difference between the two given conditions.

5. OUTLOOK FUTURE WORK
The user study presented in this article built the basis for a bigger user study conducted in November 2008 with 160 participants. For this follow-up study new conditions were set up, regarding the level of certainty the robot gives in its advice – (1) I would choose another card; (2) Choosing the other card will increase your chance to win; (3) Choosing the other card will increase your chance to win up to 66%.

6. REFERENCES