Modeling the antecedents of system trust

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Abstract

Although many have studied the effects of outcome feedback on system trust, little is known about the formation of trust when such unequivocal information is absent. Such situations presumably cause users to rely on less concrete information, such as information from others, and process feedback. The aim of this paper is to establish the effects of these types of information, and to apply the Heuristic-Systematic Model to model how such sources may affect trust in a route planner.

An experiment was conducted to test the effects of heuristic cues (consensus information) and process feedback (consistent versus random) on system trust. Results show that consensus information is used at least initially to form trust in a route planner. Random process feedback was shown to have an additive effect on trust. Consistent process feedback, however, was shown to attenuate the effect of negative consensus information.

1. Introduction

A lack of sufficient knowledge about the functioning of a system may cause its users to feel uncertain, especially when an element of risk is involved. The need for more knowledge, however, can often not be satisfied. Trust can be considered as an alternative mechanism to reduce such feelings of uncertainty (Luhmann, 1979). Therefore, the concept of system trust is crucial in understanding people's decision to rely on system support. In our view, it is equally important to study how information is used to come to this decision. In this paper we will identify some types of information that have largely escaped attention, and propose a model that may be helpful in understanding how they influence the formation of system trust.

Various types of information have been suggested to influence trust formation. For instance, users may base their judgement on indirect experiences, such as the reported experiences or recommendations of others, or on direct experiences, which is gained by actually interacting with the system (Arion, Numan, Pitariu, & Jorna, 1994). Direct experience yields information about the system's behaviour over time. Repeatedly yielding satisfactory output, the system may be perceived as predictable, consistent and stable, thus enabling users to anticipate future system behaviour (e.g., see Lee & Moray, 1992; Zuboff, 1988).

Most researchers studying system trust have focused on a single type of direct experience, namely output feedback. Typically, the focal system yields unequivocal output errors, such as under- or overheating of juice in a pasteurisation plant (Lee & Moray, 1992; Muir, 1989), which are subsequently shown to influence trust and reliance on automation.

Such blatant errors, however, may not be strictly necessary for direct experiences to influence trust. Woods, Roth, and Bennett (1987), for example, found indications that technicians sometimes base system trust on mere process feedback, i.e., feedback concerning the process of finding a solution, instead of output feedback. Apparently, process feedback also contains information that is used to form an opinion.

We believe that one trust-relevant aspect of process feedback is predictability. Presumably, users conclude there is a reason why a system's process feedback shows a particular recurrent pattern. For instance, a detour around a certain area on the map may be explained by the system trying to avoid high traffic density inside that area, ongoing roadwork, traffic lights, etc. Although such explanations do not necessarily match the system's actual procedures, these beliefs about the system's functioning may increase a user's willingness to rely on system advice.

Normally, users may have multiple concurrent types of information available to help them form a trust judgement about a particular system; besides their own experiences, based on process and outcome feedback, the opinions of others may also be influential. Exactly how these types interact is unclear. Potentially important in this regard may be the amount of information obtainable per type: indirect experience may yield less information than direct experience, and hence, results in more uncertainty than direct experience (Arion et al., 1994).

We feel that a model is needed that incorporates the effort needed to process information. Information that

is easily processed, such as the opinion of someone else, may be preferred over information requiring more effortful processing in situations of low importance. When a task is important, however, it may be worthwhile to scrutinise all available information, for example both someone else's opinion and process feedback, even though the latter requires more effort.

One eligible model, established in the fields of persuasion and attitude research, is the Heuristic-Systematic Model. Applying this model to system trust may be instrumental in understanding and predicting the influence of different concurrent types of information, direct and indirect, on system trust.

The Heuristic-Systematic Model (HSM) (Chen & Chaiken, 1999) posits that people may use two distinct modes of information processing when they evaluate. The systematic mode pertains to effortful scrutiny of all available information, whereas heuristic processing involves the use of simple decision rules such as "the majority is always right" or "experts can be trusted". Heuristic processing is the default mode; when people feel a need to be more certain about their evaluation, e.g. when the outcome of the evaluation is important, they may engage in additional systematic processing. Specifically, any discrepancy between people's judgemental confidence and the confidence they feel is needed to accurately form an opinion about something (i.e., "sufficiency threshold") motivates people to engage in additional systematic processing of available information. The magnitude of that discrepancy depends on individual differences, but also on the risk involved, task importance, and uncertainty.

Furthermore, the HSM explicitly assumes concurrence of systematic and heuristic processing, and postulates both independent and interdependent influences (Chen & Chaiken, 1999). First, as systematic processing will provide more judgement-relevant information than heuristic processing, systematic processing is expected to attenuate the impact of heuristic processing, especially when the actual message blatantly contradicts the validity of heuristic cues. Second, heuristic and systematic processing can be expected to produce additive influences when both modes yield congruent information. Last, when the provided persuasive arguments are somehow ambiguous, both modes may exert an interdependent influence, in that processing of heuristic cues may establish expectancies about message validity, which in turn may bias systematic processing of information.

2. Route Planner Experiment

An experiment was conducted to establish the effects of direct and indirect information on trust, and demonstrate the application of the HSM in the field of system trust, under circumstances of high task importance. We pitted others' opinions concerning a route planner (heuristic cue) against process feedback (requiring more effortful processing). The former was manipulated by supplying minority versus majority endorsement information; process feedback was manipulated by displaying routes that consistently favoured arterial roads (Consistent Process Feedback) versus routes selected randomly from a subset of alternatives (Random Process Feedback).

We expected that Consistent Process Feedback would increase knowledge about the system, which would influence trust, overruling the effect of consensus on the after-interaction trust measures. Contrarily, Random Process Feedback would provide no such information; hence, the information from the consensus manipulations would be used to make sense of the process feedback; consequently, Consensus would influence both before- and after-interaction trust measures.

2.1. Design

Twenty-four undergraduate students received 3 Euro (approximately US$ 3) for participation in this study. The experiment had a 2 (Consensus: minority endorsement versus majority endorsement) * 2 (Process Feedback: random versus consistent) within-participants design.

2.2. Procedure

On arrival at the laboratory, participants were seated in separate cubicles, where the experiment was run at computers. They were instructed to interact with four new types of route planners that looked identical, but supposedly used different algorithms to determine optimal routes. Figure 1. shows the route planners' interface.

Using a city map of London, participants were requested to perform a professional route dispatcher's task by sending quickest possible routes to imaginary cars, the current location and destination of which were indicated on the screen. By clicking a button labelled "Automatic" the route-generating process was started; by clicking "Accept" it was supposedly sent. As all participants were Dutch, we can safely assume that, although some may have actually visited London, they are not sufficiently familiar with London traffic to actually evaluate the route quality. Therefore, route display constitutes process feedback, instead of output feedback.

Per route planning trial, participants received credits, which could be put at stake in a bet. Comparison of each generated route with a database containing extensive real-life route information resulted in loss of the credits when a route was judged slower, or a

doubling when it was faster. Thus, participants could accumulate credits over all trials; the total sum supposedly determined the amount of money they would receive for their participation. We assumed that this would increase task importance.

Before and after interacting with each of the four route planners, participants rated their trust in the system's advice on a 7-point scale, ranging from "very little" (1.) to "very much" (7.).

Finally, participants were debriefed, thanked and paid. All participants were rewarded equally.

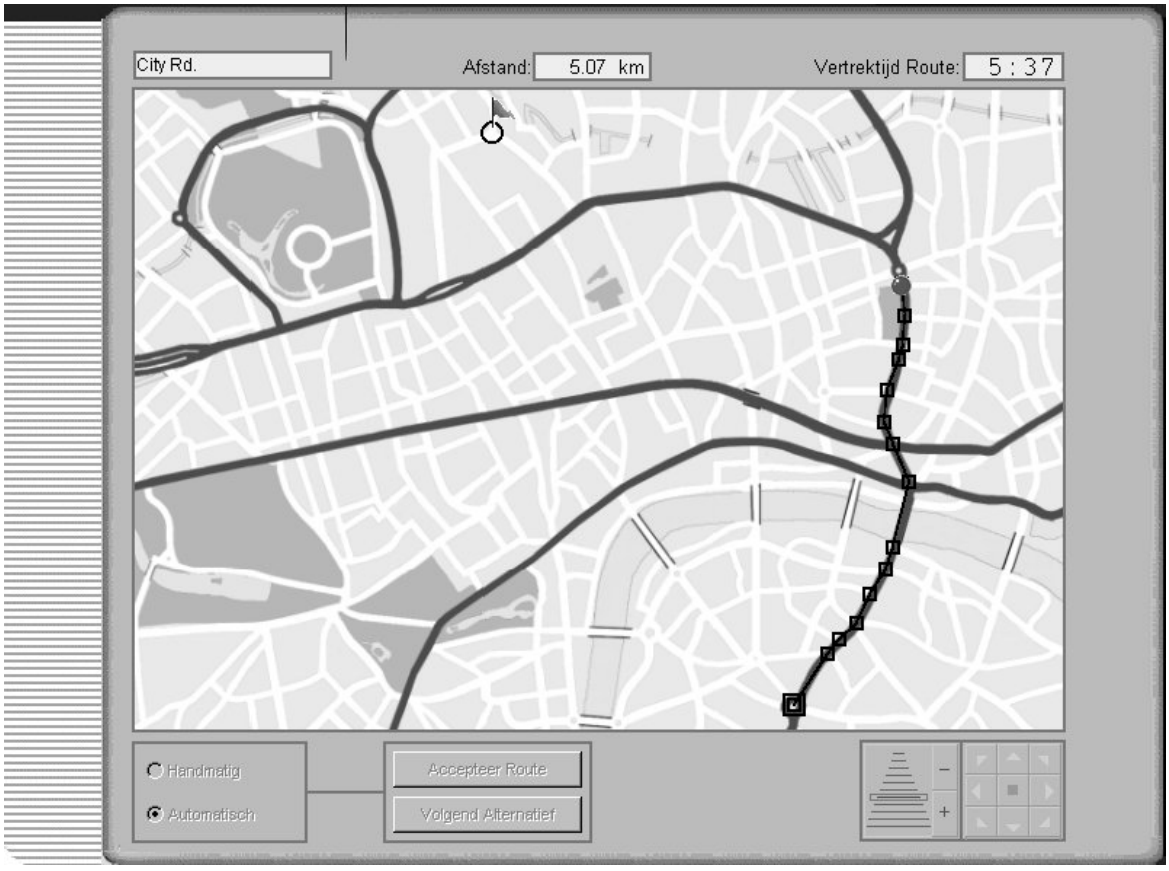

Figure 1: Screen dump of the route planner program

3. Results

The average trust ratings are displayed in Figure 2.

A repeated-measures analysis of variance yielded a significant main effect of Consensus on both on the before-interaction-, and the after-interaction trust measures, F (1, 31) = 73.8; $p < .01$, and F (1, 31) = 5.1; $p = .03$, respectively. Trust was rated higher after a majority cue than after a minority cue. Furthermore, a significant main effect of Process Feedback was found, F (1, 31) = 7.8; $p < .01$, indicating that trust measures were higher after Consistent than after Random Process Feedback.

To test our hypotheses, separate repeated-measures ANOVA's were performed for Random and Consistent Process Feedback, with Consensus and Time as independent variables.

For Consistent Process Feedback, a main effect of Consensus was found, F (1, 31) = 27.9; $p < .01$, indicating that trust ratings were higher when a majority cue had been given, than they were after a minority cue. No main effect of Time was found, F (1, 31) < 1, ns. Consistent with our hypothesis, a highly significant interaction was found, F (1, 31) = 25.5; $p < .01$, indicating that the Consensus manipulations only had an effect on before-interaction trust measurements, but not on the after-interaction measurements.

For Random Process Feedback, a significant main effect of Time was found: after-interaction measures were lower than before-interaction measures, F (1, 31) = 9.1; $p < .01$. As expected, both before- and after-interaction measures were significantly higher following a majority endorsement message than they were after a minority endorsement, F (1, 31) = 25.7; $p < .01$. No interaction was found, F (1, 23) = 2.9, ns.

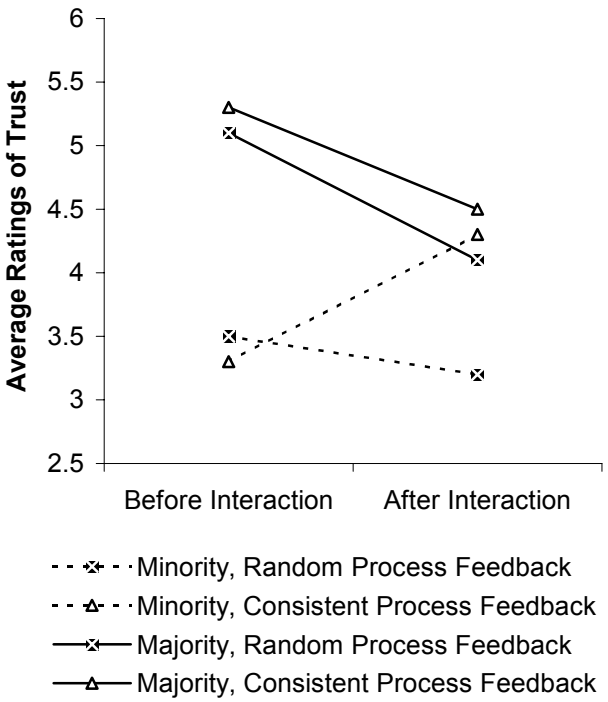

Figure 2: Effects of Consensus and Process Feedback on Before- and After-Interaction Trust Measurements

4. Discussion

In sum, an endorsement cue provided participants with information that was used to build trust on. Furthermore, also process feedback, obtained during interaction with the system, provided information that was used to judge the system in terms of trustworthiness. Consistent with our hypotheses, the combined effects of cue and feedback depended on the characteristics of the feedback, i.e. random or consistent. Clearly, these types of information, whether they occur separately or simultaneously, deserve the attention of researchers studying system trust.

How, then, can the HSM be used to explain these results? First, we assume that staking credits motivated participants to incorporate both consensus information and process feedback. Consequently, they probably noted the regularity in consistent process feedback, and used that to base their trust judgement on. However, endorsement information was also used to base trust on, majority endorsement leading to high trust levels, and minority endorsement to low trust. Therefore, when endorsement information was provided in combination with consistent process feedback, there may have been a contradiction between consensus information causing low versus high trust, and process feedback causing more intermediate trust levels. This may have resulted in the attenuation of the effect of both negative and positive consensus information, as the HSM predicts. Finally, random process feedback provided indefinite information, causing participants to call upon consensus information to make sense of it. As such, endorsement information and process feedback could reasonably be considered congruent; the additive effects of consensus and process feedback therefore match the HSM's additivity hypothesis.

In sum, the HSM constitutes a model that may be useful for those interested in system trust and its different antecedents. Although the data discussed here are insufficient to actually validate the HSM in this context, we hope they will initiate further effort in this direction. An important step would be to show that whether trust is based solely on the easiest obtainable evidence, e.g. simple cues like recommendations, or on evidence requiring more effortful elaboration, e.g. process feedback characteristics, is determined by motivation. When it comes to trust, considering the efforts required to process different types of information and the willingness to spend that effort promises valuable insights into decisions of users in interaction with a system.

5. References

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