The Influence of Causal Attributions on Users’ Problem-Solving Motivation

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Abstract

This study used longitudinal data collected from 109 participants to investigate the impact of computer-related causal attributions on users’ problem-solving motivation. Attribution theory deals with subjectively perceived causes of events and is commonly used for explaining and predicting human behavior, emotion, and motivation. Individual attributions may either positively or negatively influence one’s learning behavior, confidence levels, effort, or persistence. Results indicate that computer-related causal attributions indeed influence users’ problem-solving motivation. Users with favorable attribution styles exhibit greater levels of motivation in problem handling than users with unfavorable attribution styles. The findings can be used in HCI research and practice to understand better why users think, feel, or behave in a certain way. It is argued that an understanding of users’ attributional characteristics is valuable for developing and improving existing computer learning training strategies and methods, as well as support and assistance mechanisms.

1 Introduction

Despite intensive efforts by system developers and designers to facilitate the use of technologies, usability problems, frustration with technologies, and other unwanted responses remain common. In this regard, *Attribution Theory* is a promising approach to understand better how user characteristics impact their use motivation, especially when problems arise. Attribution theory deals with causal explanations people find for successful and unsuccessful outcomes and how they influence individuals’ behavior, emotion, and motivation (Weiner, 1974; Weiner, 1985). This paper contributes to HCI research and practice by applying attribution theory, which to date has not received ample attention in the HCI community (e.g., Kelley et al., 2013), although it is one of the most influential bodies of research of social psychology in the last 50 years (Martinko et al., 2011). To our knowledge, the impact of attributions on the users’ motivation to solve computer problems has not been investigated yet. However, a deeper understanding of how Causal Attributions impact users’ problem-solving motivation can help to design systems that fit their users’ need better. In this paper, problem-

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solving motivation is defined as persistence and the readiness or the level of effort users are willing to spend to solve computer-related problems. Thus, the goal of this study is to explore the relationship between different computer-related attribution patterns and the problem-solving motivation of computer users. Strategies for avoiding and reframing negative computer experiences are also considered.

2 Theoretical Background and Related Work

In attribution research, a distinction is made between *internal* and *external* causes (*locus*) perceived by the individual. For example, a person may either feel responsible for a positive or negative outcome (internal) or relate it to external circumstances (Heider, 1958). Three further dimensions are distinguished: *Stability*, *controllability*, and *globality* (Weiner, 1974). Causes are considered as *stable*, i.e. persistent over time or as *unstable* and singular. Furthermore, causes can be perceived as *controllable* or *uncontrollable*, as well as generally taking effect (global) or only applicable to a certain (specific) situation (Stiensmeier-Pelster et al., 1994).

Stable attribution patterns which are present in a wide range of situations are called *Attribution Styles*. Originally, attribution styles derive from clinical psychology to explain and predict depression. Persons with a *pessimistic* attribution style tend to blame themselves when things don't go right (e.g., "it was my fault") and will not take credit for success, (e.g., "I was just lucky"). Contrary, persons with an *optimistic* style rather take credit for success and do not put the blame on themselves for things that go wrong (cf. Abramson et al., 1978; Kelley et al., 1999), (Seligman, 2006)). Overall, people with an optimistic attribution style are more likely to succeed (Henry et al., 1993).

Research has shown that attributions are domain specific (e.g., Weiner, 1974; Anderson et al., 1988) and therefore attribution patterns reported in other research areas may not represent the perceptions of computer users. They may even be completely unsuitable for an application in the HCI domain. Moreover, the application and theoretical testing of attribution theory is fairly young in the field of HCI research, compared to other disciplines. Nevertheless, it has already received some recognition and was found to be relevant in some HCI research issues. For example, it has been applied to explain computer system adoption (Henry & Martinko, 1997), effects on users' evaluations of system quality (Niels, Guczka, et al., 2016), post-training reactions to and performance of computer systems (Rozell & Gardner, 1999), development of strategies to overcome computer anxiety (Phelps & Ellis, 2002), course performance (Henry et al., 1993), and satisfaction (Barki, 1990). For a detailed review of attribution theory in the context of HCI, see (Kelley et al., 2013). Interestingly, the effects of causal attributions on users' problem-solving motivation have not been researched yet.

Current research on attribution theory in the field of HCI clustered people with regard to their computer-related attributions and developed a typology of six central computer-related attribution styles, three styles each for situations of success and failure. Similar to clinical psychology, optimistic styles (characterized by a feeling of control toward the technical systems) and pessimistic styles (marked by feelings of helplessness and resignation), as well as more 'neutral' styles, were found (Niels & Janneck, 2015). For *situations of success*, the *Confident*, the *Realistic*, and the *Humble* style were identified. Persons with a *Confident* style may explain their computer-related successes as "I am competent and responsible for my own success". They tend to attribute success to internal, stable, controllable, and global causes. Persons with a *Realistic* style expect that "Sometimes I am successful, sometimes not". They attribute the reasons for success rather temporally unstable and situation-related. For persons with a *Humble* style, the explanation is "This time I was lucky". They attribute success to external factors and experience only low levels of control when using computers (Niels & Janneck, 2015). For *situations of failure*, the *Confident*, the *Realistic*, and the *Resigned* styles were found. Persons with a *Confident* style reckon "I know it was my fault, but next time I will do better". They have high internality values and feel responsible for their failures, but also feel in control of the situation. For persons with a *Realistic* style, the explanation is "This time I failed, but I don't worry about it". They see internal as well as external reasons for failures and believe that they change over time and depend on a specific situation. Finally, if a failure occurs, persons with a *Resigned* style might feel "I never understand what computers do". They see external and temporally stable reasons for their failure and feel they have little control over the situation (Niels & Janneck, 2015). We will build on this typology of computer-related attribution styles in our study.

3 Methodology

3.1 Sample

A total of 109 persons participated in this study (57 female and 52 male). The mean age was 51.93 years (Median=50, SD=7.96 years, range: 34-68). The general level of education was quite balanced, ranging from completed junior high school up to university degree. They subjectively self-assessed their computer skills on a 7-point Likert-type scale ranging from 1 (low) to 7 (expert) on average at 5.31 (SD=1.25, range: 1-7). In order to provide a well-balanced sample, participants were paid and recruited via an online research panel.

3.2 Measures

Attribution Questionnaire. The Attribution Questionnaire is an established and validated questionnaire to determine users causal attributions in the field of HCI (Dickhäuser & Stiensmeier-Pelster, 2000; Guczka & Janneck, 2012). The instrument includes hypothetical depictions of events, five addressing positive outcomes (success) and five addressing negative outcomes (failure). Sample events included, "Imagine you are working on a foreign computer. It is very easy for you to adapt to the new and unknown user interface." (success) and "Imagine while creating a document with the computer, you delete a text page. You are not able to recover this page." (failure). Subscales include questions regarding the perception of locus, stability, controllability, and globality. The items are answered on a 7-point Likert-type scale. Table 1 shows an excerpt from the English version of the questionnaire for failure situations.

The items measuring attributions in situations of success are worded analogously. The construct allows to examine attributional dimensions separately, but also to determine overall attribution styles by using cluster analyses.

What caused the breakdown?		
I would locate the cause of the breakdown…		
internally (I am to blame)	1 2 3 4 5 6 7	externally (the system is to blame)
The cause of the breakdown is…		
a singular event	1 2 3 4 5 6 7	recurring
The cause of the breakdown is…		
controllable	1 2 3 4 5 6 7	uncontrollable
The cause of the breakdown is likely to promote other breakdowns…		
just in this situation	1 2 3 4 5 6 7	in other situations as well

Table 1: Excerpt from the Attribution Questionnaire for failure situations
(Dickhäuser & Stiensmeier-Pelster, 2000; Guczka & Janneck, 2012).

Motivation Questionnaire. The questionnaires available are mostly related to individuals' general strategies/processes used in problem-solving and do not refer to computer use. However, to our knowledge, there is no adequate questionnaire to assess the level of persistence users are willing to spend to solve computer-related problems. Therefore, we used a five-item measure with four additional hypothetical descriptions of negative events. This was necessary to determine the problem-solving motivation independently of the general computer-related attributions. The descriptions were extracted from prior studies (cf. Niels & Janneck, 2015) where participants were asked to depict computer-related failure experiences. We selected those that appeared most common, that were easy to imagine, and that ideally offer a broad range of interpretations to exclude that they evoke a certain causal explanation from the outset e.g., "Imagine you want to attach a picture to an e-mail but it does not work". The participants were asked to imagine these situations, to consider how they would react in case of such an error and to evaluate their motivation in relation to their persistence to solve the problem. The content validity of the motivation questionnaire (Table 2) was ensured by closely linking the formulation of the items to the definition of the intended construct. In addition, the item formulations were subjected to an expert review and subsequently optimized in a cognitive pretest with the selected target group. Cognitive pretests are used to determine whether participants are interpreting the survey items as intended. To assess the construct validity, the correlation with the motivational aspects of the 27-item scale developed by Janneck et al. (2012) was determined, a measure for the construct computer-related self-concept (CSC-Questionnaire). The motivation questionnaire shows a high convergent validity with the motivational aspects of the CSC ($r=.931$, $p<0.001$). Finally, to assess the reliability of the construct, Cronbach's Alpha was calculated. The internal consistency for the subscales is between $\alpha=.642$ and $\alpha=.883$, and for the overall scale at $\alpha=.872$, which is a sufficient degree of reliability (Table 2). The items are answered on a 7-point Likert-type scale ranging from 1 (yes, very) to 7 (no, not at all). Table 2 shows the final English version of the questionnaire.

Item	Mean	SD	α
I am motivated to solve the problem.	2.10	1.11	.790
I lose the desire to do the task.*	3.04	1.61	.883
I am inclined to give up.*	2.57	1.43	.825
I would try until it works.	2.05	0.95	.642
I try to fix the problem.	1.86	0.92	.677
Overall scale	2.32	1.00	.872

*Table 2: Motivation Questionnaire items and results. Items denoted by * are inversely coded. Mean values and standard deviations for items and overall scale.*

3.3 Procedure

Data were collected at five points in time over a three-week period. This was done to get a more reliable measure and make results more independent of the effects of mood, condition, and other singular effects that might influence motivation. In each round, the participants were presented with two of the ten hypothetical events (one success and one failure situation) to measure attributions. The participants were instructed to imagine the respective situations as lively as possible and to assess the cause of each situation on the four attributional dimensions of locus, stability, controllability, and globality. In the first round, additional measures of demographics and computer experience were administered. From the second round onwards, the participants were also presented with an error description (as depicted above) to measure their problem-solving motivation.

4 Results

K-means clustering was used to classify the attribution data into existing clusters and to determine the attribution styles for each participant. Clusters identified in prior studies (Niels & Janneck, 2015) served as the basis for classification.

Success	**Confident**	**Realistic**	**Humble**	**F value**	**p**	**η^2**
Locus	2.44	2.95	4.46	45.718	<0.001***	0.463
Stability	6.14	4.25	5.21	40.604	<0.001***	0.434
Controllability	1.48	2.25	3.63	91.411	<0.001***	0.633
Globality	5.64	3.61	4.45	49.099	<0.001***	0.463
Failure	**Confident**	**Realistic**	**Resigned**	**F value**	**p**	**η^2**
Locus	3.53	4.21	5.24	35.329	<0.001***	0.400
Stability	4.48	3.20	5.11	48.176	<0.001***	0.476
Controllability	3.09	3.19	4.55	31.861	<0.001***	0.375
Globality	3.65	2.42	4.36	45.643	<0.001***	0.400

Table 3: ANOVA results for success and failure clusters.

The distribution of the individual clusters is relatively balanced: For *success situations*, cluster analysis revealed 37 with a *Confident*, 34 with a *Humble*, and 38 with a *Realistic* attribution style. For *failure situations*, cluster analysis revealed 38 with a *Confident*, 43 with a *Resigned*, and 28 with a *Realistic* attribution style. Table 3 shows the mean values for the six clusters. ANOVAs were calculated showing significant differences between clusters. Effect sizes (according to Cohen's classification of η^2, (Cohen, 1988)) are high.

4.1 Motivation Questionnaire

In a first step, inversely coded variables were inverted. Lower values on the overall scale as well as the subscales indicate a higher problem-solving motivation. The results show that the overall problem-solving motivation of the participants is quite high (Table 2). Additionally, the relations between problem-solving motivation and participants' self-assessed computer skills were analyzed to exclude a potential influence of this factor. However, no correlations were found (r=-.162, p=0.092).

4.2 Correlation Analysis

Attribution styles and problem-solving motivation were tested globally for differences followed by post-hoc tests (LSD) for pairwise comparison. Because of non-normally distributed data the Kruskal-Wallis-Test was used instead of analyses of variance.

Kruskal-Wallis tests revealed significant differences concerning situations of success and failure (Table 4). Post-hoc tests results show that users with favorable attribution styles exhibit more motivation to solve computer problems. Table 5 shows the results of the post-hoc test and the problem-solving motivation mean values for each attribution style.

	Chi^2	**df**	**p**
Success	16,354	2	<0.001***
Failure	10,032	2	0.007**

Table 4: Relations between attribution styles and problem-solving motivation in situations of success and failure - results Kruskal-Wallis test.

In *situations of success*, the analysis showed significant differences between persons with the *Confident* and the *Realistic* styles (p=0.001; M=1.80 vs. M=2.58), as well as between persons with the *Confident* and the *Humble* styles (p=0.001; M=1.80 vs. M=2.60). Persons with the more favorable *Confident* attribution style exhibit greater levels of motivation in problem handling than users with the *Realistic* or *Humble* style.

In *situations of failure*, the analysis showed significant differences between persons with the *Resigned* and the *Confident* (p=0.024; M=2.83 vs. M=2.27) styles, as well as between persons with the *Resigned* and the *Realistic* (p=0.001; M=2.83 vs. M=2.04) styles. Persons with the favorable *Confident* and the more neutral *Realistic* attribution styles exhibit greater levels of motivation in problem handling than users with the unfavorable *Resigned* style.

Success	Mean Motivation		p
Confident	1.80	Realistic	0.001**
Realist	2.58	Humble	0.939
Humble	2.60	Confident	0.001**
Failure			
Confident	2.27	Realistic	0.277
Realist	2.04	Resigned	0.001**
Resigned	2.83	Confident	0.024*

Table 5: Relations between attribution styles and problem-solving motivation - Post-hoc test (LSD).

5 Discussion

This study aimed to examine the relationship between computer-related attribution styles and users' problem-solving motivation. This section discusses the findings of the present study, its limitations, and offers suggestions for future research and practice. The results show that attribution styles indeed impact users' problem-solving motivation. Users with the favorable *Confident* attribution style are significantly more motivated i.e. persistent to solve computer problems than persons with the more unfavorable *Resigned* or *Humble* style, respectively.

5.1 Implications and Recommendations

The findings can be used in HCI research and practice to understand better why users think, feel, or behave in a certain way. Thus, design principles could be developed to support different types of users in a specific way. To our knowledge, this is the first study that directly examines the impact of computer-related causal attributions on users' problem-solving motivation. Therefore, this study contributes to a more complete and detailed knowledge of users' computer-behavior. The results encourage further research on causal attributions as personality traits in HCI research.

There are also implications for practitioners who develop and design computer systems. This study sheds light on different types of computer users regarding their explanations for successful and unsuccessful outcomes when working on computer-related tasks. In order to assist people to become more motivated in problem-solving, several measures might be explored. For example, *attributional retraining* (Försterling, 1985), which suggests that individuals' performance will increase when they learn to ascribe causes to more favorable attributions, could be a promising approach. Thus, our results are valuable for developing and improving existing computer learning training strategies and methods, as well as support and assistance mechanisms for users. Practitioners should attempt to adapt these findings and design specified systems by, for example, including attributional retraining strategies. This could be done, for example, by providing feedback that changes the beliefs of the users about the cause of computer-related outcomes (e.g., comments that contain the desired attributions). A first approach in this direction was made by (Niels, Lesser, et al., 2016). They investigated the effect of different attributional wordings of error messages. System developers and designers should bear this in mind and future research should take this into consideration.

5.2 Limitations and Future Research

The present study also faces some limitations. First, despite the careful selection of the participants, the sample is relatively homogeneous regarding their self-assessed computer expertise. This might limit the generalizability of our findings since there is some evidence that this has an impact on attribution processes (Niels et al., 2015). This could also be an explanation for the generally high motivation to solve computer problems. Nevertheless, our analysis clearly revealed the six distinct attribution styles that were also found in prior studies (e.g., Niels & Janneck, 2015; Niels & Guczka, 2016). We believe that a higher variance regarding this factor would lead to even stronger differences. Therefore, future research should try to involve a more balanced sample.

The research design of this study also carried certain limitations. Standardized hypothetical use situations were chosen to create a similar experience for all participants. However, a drawback of this method is that the situations were somewhat artificial and unrelated to the participants' normal use habits, which might result in reduced intensity and significance of the imagined situation (see Niels & Janneck, 2015 for a comparison of different data collection methods). Future research should bear this in mind and investigate these relations in real use situations.

Furthermore, participants are from Germany only and there is some evidence that people from other countries differ in their attributions (Janneck et al., 2016). In this regard, future studies should investigate cultural differences by expanding into a more international context.

The results presented here give first insights regarding the relation of computer-related attributions and users' problem-solving motivation. More research is needed to provide a rich understanding of how and to what extent these factors play a role in HCI research and practice. In this regard, it should be noted that this study has an explorative character. Nevertheless, this calls for more research to corroborate the findings. Therefore, our next step is to investigate the relations in more detail as well as the effects of reattribution training methods on the users' motivation to solve computer problems.

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