Computer-Related Attribution Styles: Typology and Data Collection Methods

Adelka Niels(✉) and Monique Janneck

Luebeck University of Applied Sciences, Luebeck, Germany
{adelka.niels,monique.janneck}@fh-luebeck.de

Abstract. Attribution, i.e. the systematic ascription of causes to effects in situations of failure or success, has so far received little attention in HCI research. Based on a preliminary typology developed in pilot work, we conducted four empirical studies with a total of N = 146 participants using different methods for data collection, including laboratory studies, a mobile diary study, and an online survey. Results show that several typical styles of attributing computer-related failure or success could be identified. Therefore, we propose a typology of six main attribution styles, which are depicted as personas to make them applicable for HCI practice. Methodical issues in computer-related attribution research and implication for research and practice are discussed.

Keywords: Attribution · Computer-related attitudes · Computer mastery · Computer failure · User types · Personas

1 Introduction: Attribution Research

Causal Attribution research deals with the explanations people find in situations of success and failure for *why* things happened the way they did, and the extent of *control* that people feel they have over external events [1]. The way people explain success or failure can be classified in four dimensions: *locus*, *stability*, *controllability*, and *globality* [e.g. 2, 3].

- *Locus* (internal vs. external) describes whether a person sees internal (“I did not study enough”) or external (“the exam was too difficult/the examiner was unfair”) causes of an event.
- *Stability* (temporally instable vs. temporally stable) captures whether causes change over time (“This time I failed”) or not (“I always fail”).
- *Controllability* (high control perception vs. low control perception) distinguishes controllable causes (“I could have studied more”) from causes perceived as uncontrollable (“Studying more would not have helped”).
- *Globality* (specific vs. global) describes whether the cause relates to a specific situation (“I just don’t like this subject”) or if it is a global cause (“I never do well in written exams”).

Attribution processes are highly relevant for people’s behavior, emotions, and motivation [1, 4]. For example, attributing a situation of failure within the internal/stable dimensions can lead to shame or humiliation because causes are attributed to the self and seen as

J. Abascal et al. (Eds.): INTERACT 2015, Part II, LNCS 9297, pp. 274–291, 2015.
DOI: 10.1007/978-3-319-22668-2_22

something that cannot be changed. Contrary, internal/instable attributions might also cause self-doubts and self-reproach, but the situation is seen as a singular event that will not necessarily occur again. If a situation of failure is attributed within the external/stable dimension there is less motivation to change. Recurring attributional patterns in different situations and contexts are called *attribution styles*. Attribution styles are considered as part of one's *self-concept*, which represents all of a person's self-referred attitudes [5]. Therefore, attribution styles can be seen as rather stable over time.

We believe that different attribution styles have different influences on user experience and behavior. For example, users with different attribution styles might have quite different explanations for events like system failures, triggering different user responses. Thus, having favorable or unfavorable attribution styles, respectively, might account for differences regarding computer mastery, computer anxiety, or simply different styles of using computers, as has been shown in different studies (for an overview see [6]). Therefore, a detailed knowledge of computer-related attribution styles might help to understand user behavior and difficulties when using computers better.

Even though there is evidence that attribution styles are domain-specific [cf. 6], so far no extensive model of specifically computer-related attributions has been developed. Thus, our research aimed at exploring distinct *computer-related attribution styles*.

A first typology of nine specific attribution styles was identified in two pilot studies, namely a diary study and an online survey [7]. Stereotypical names and exemplary statements were used to illustrate the kind of attitude and behavior that might be associated with the respective attribution style (Table 1).

Table 1. Typology of computer-related attribution styles [7]

	Style – Description	*Diary*	*Survey*
Success	Realistic – "Sometimes I am successful, sometimes not"	x	x
	Humble – "This time I was lucky"	x	x
	Lucky guy – "Everything I do turns out right"	x	x
	Confident – "I am competent and responsible for my success"	x	x
	The Boss – "Success depends on the system, but I control it"		x
Failure	Realistic – "This time I failed, but don't worry about it"		x
	Shrugging – "Every failure is unique"	x	x
	Confident – "I know it was my fault, but next time I will do better"	x	x
	Resigned – "I never understand what computers do"	x	x

In this paper, the primary objective was to reproduce and refine this typology and therefore present a validated concept, which can be used in further HCI theory and practice. Furthermore, we aimed to explore and compare different data collection methods.

2 Research Questions and Methods

In this paper, we investigated the following main research questions and objectives:

- Identification of a main set of computer-related attribution styles that can be reproduced in a variety of different settings, using different methods for data collection;

- Exploration of the differences, advantages and drawbacks of different research instruments and recommendations for further research.

To that end, we investigated computer-related attribution styles by means of four different data collection methods: A *laboratory study* with standardized use situations; a *mobile diary application* to measure attributions in everyday use situations; an *attribution questionnaire* which was filled out by participants as part of a *usability test*; and an *online survey* recording retrospective memories of computer-related situations of success and failure. Participation in all studies was anonymous. Therefore, it is possible that some persons have participated in more than one study. The studies are described in detail in Sects. 3, 4, 5 and 6.

In all four studies the same measure was used in order to compare the results, which had been developed and tested in the pilot studies [7]. In addition to four questions measuring the attributional dimensions of locus, stability, controllability and globality (Fig. 1, based on the Sport Attributional Style Scale, SASS, [8]), participants were asked to briefly describe the cause of failure or success and also rate its significance and task difficulty. Furthermore, socio-demographic data (e.g. age, gender, education, general computer use and experiences) were collected.

In this measure, low values for *locus* mean that a person attributes reasons for success (e.g. "I am competent") or failure (e.g. "It was my fault") internally, while high values indicate that they attribute reasons to external factors (e.g. "The system is stable and runs well" vs. "The system is to blame"). Low *stability* values mean that causes are believed to change over time (e.g. "This time I was lucky" vs. "This time I failed"), high stability values indicate recurring events (e.g. "I am always right" vs. "I always fail"). Due to the wording of the questionnaire, low values of *controllability* indicate high perception of control (e.g. "success is due to my diligence" vs. "I did not try hard enough"), while high values of controllability indicate low perception of control (e.g. "I was lucky" vs. "I cannot change the situation anyway"). Finally, low values of *globality* indicate that attributions are not generalized to other situations (e.g. "I can handle this specific application well" vs. "I just don't understand this specific application"), while high values of globality indicate that similar attributions take place in different contexts (e.g. "I always do well with computers" vs. "I never master computer applications").

1. 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)
2. The cause of this breakdown is...		
a singular event	1 2 3 4 5 6 7	recurring
3. The cause of the breakdown is...		
controllable	1 2 3 4 5 6 7	uncontrollable
4. The cause of this breakdown is likely to promote other breakdowns...		
just in this situation	1 2 3 4 5 6 7	in other situations as well

Fig. 1. Part of the standardized attribution questionnaire for failure situations [7]

The data was analyzed using hierarchical cluster analyses as an exploratory instrument for discovering structures in raw data [9, 10]. Firstly, we measured each subject's level of attribution per dimension collected over each situation. Secondly, we built a matrix, containing the distance (calculated via Euclidian measures) between the subjects regarding each dimension. After that we clustered each subject or group of subjects together, while keeping the inner cluster variance low, using Ward's method for computing the cluster linkage criterion. Finally, to rule out which cluster solution stands out, we considered the variance changes and the plotted structure (dendogram) for each data set [11].

3 Study 1 - Laboratory Study

3.1 Research Methodology

In the first study we investigated computer-related attribution styles in a laboratory setting, conducting usability tests. The participants were asked to edit three task pairings on three different applications or devices, whereby one task of each pairing was easy to solve (situation of success – e.g.: Search for the district office opening hours on a municipal home page) and one task was hard or even insolvable (situation of failure – e.g.: Search for the building regulations of a certain district, which did not exist on the homepage). After each task the participants filled out the attribution questionnaire described in Sect. 2.

3.2 Results

In all, 58 persons participated in the study (48 % female, 52 % male). Mean age was 34 years (range: 17–75 years). The general level of education was quite high (76 % with high school or university degree). On average they had 13 years (range: 0–30 years) of experience in private computer use and 10 years (range: 0–32 years) experience using computers at school or in the workplace. Participants self-rated their computer skills on Likert scales ranging from 1 (low) to 7 (expert) in the various categories: Operating Systems (M = 4.34), Internet (M = 5.14) and Applications (M = 3.82).

We recorded a total of 340 situations, 177 success situations and 163 failure situations. (This imbalance was due to individual perceptions of the outcome of the task: For example, some participants also succeeded in the hard task condition, while others were not successful in the easy task condition).

Success. The attributional dimensions are only moderately inter-correlated, thus supporting the construct validity of the research instrument. Merely stability and globality correlate at r = 0.51. However, this is theoretically plausible: If people believe that success will persist over time they normally also believe that similar situations take place in different contexts.

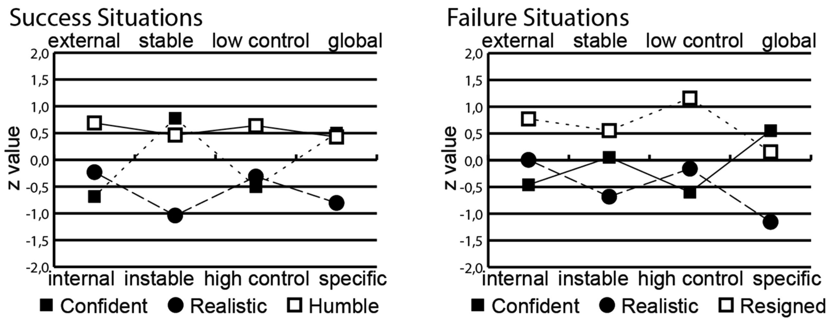

Fig. 2. Clusters for success and failure situations

For success situations, cluster analysis identified the three clusters "*Realistic*", "*Humble*" and "*Confident*" (Fig. 2).

Persons from Cluster A ("*Realistic*"– "Sometimes I am successful, sometimes not") attribute reasons for success rather temporally instable and situation-related, whereby Persons from Cluster B ("*Humble*" – "This time I was lucky") attribute success to external factors and experience only low levels of control when using computers. Compared to Cluster A and B Persons from Cluster C ("*Confident*" – "I am competent and responsible for my own success") attribute success temporally stable, globally and internally.

Table 2 shows the mean values for the clusters. ANOVAs were calculated showing significant differences between clusters. Effect sizes (according to Cohen's classification of η^2, [12]) are high.

Table 2. ANOVA results for success clusters

Cluster	A n = 21	B n = 22	C n = 15	F value	p	η^2
Locus	3.43	4.77	2.77	13.267	<0.000***	0.325
Stability	3.78	5.88	6.32	49.032	<0.000***	0.641
Controllability	1.92	3.01	1.70	9.654	<0.000***	0.260
Globality	3.77	5.34	5.43	16.573	<0.000***	0.376

Failure. Regarding inter-correlations, locus and stability correlate at r = 0.46. Furthermore, locus and controllability correlate low at r = 0.28. However, this is theoretically plausible: If people see internal causes for a situation they normally also experience higher controllability.

For failure situations, cluster analysis identified the three clusters "*Realistic*", "*Confident*" and "*Resigned*" (Fig. 2).

Persons from Cluster D ("*Realistic*" – "This time I failed, but I don't worry about it") see internal as well as external reasons for failures and believe that these change over time and depend on a specific situation. Persons from Cluster E ("*Confident*" – "I know it was my fault, but next time I will do better") have the highest internality values and feel responsible for their failures, but also feel in control of the situation. Persons from Cluster F ("*Resigned*" – "I never understand what computers do") see external and temporally stable reasons for their failure and feel they have little control over the situation. This attribution style is the most unfavorable of all thee clusters and can be compared to the so-called pattern of "learned helplessness" that is observed in patients suffering from depression [cf. 2].

As for success situations, differences between clusters were significant. Effect sizes are high (Table 3).

Table 3. ANOVA results for failure clusters

Cluster	D n = 15	E n = 27	F n = 16	F value	p	η^2
Locus	4.44	3.66	5.73	10.029	<0.000***	0.267
Stability	5.00	5.76	6.28	7.293	0.002**	0.210
Controllability	3.31	2.57	5.55	34.349	<0.000***	0.555
Globality	3.09	5.51	4.94	27.598	<0.000***	0.501

4 Study 2 – Field Study with Mobile Diary Application

4.1 Research Methodology

Participants were asked to record situations of success and failure when using computers in private or workplace situations over a period of 8 weeks by using a mobile diary application. It was up to the participants to decide whether success or failure had taken place. The diary contained ten attributional questionnaire forms each for success and failure [7]. Again, the standard attribution questionnaire was used.

Participants were recruited via extensive publicity measures, including a local newspaper article. However, as diary studies are rather laborious and time-consuming for participants, completion rates are usually low. The survey respondents were able to contact the experimenter at all times. However, we refrained from systematic reminders, which might influence participants' responses in diary studies [13].

4.2 Results

A total of 78 persons participated in the diary study. For data analysis we included all diaries that contained at least one situation of success and failure (n = 20). On average participants reported M = 3.9 (SD = 3.24; range: 1–10) successes and M = 4.0 (SD = 3.35; range: 1–10) failures. 52.6 % of the respondents were female. The mean age of respondents was 34.32 years (range: 19–74 years). The general level of education was quite high (73.7 % with high school or university degree). On average they had 14.95 years (range: 7–21 years) of experience in private computer use and 11.42 years (range: 0–21 years) experience using computers at school or in the workplace.

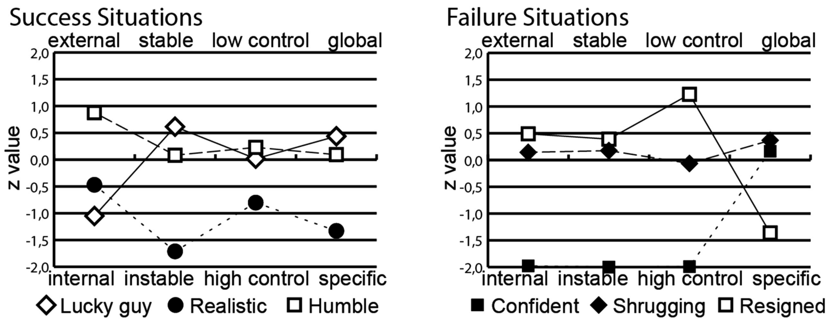

Fig. 3. Clusters for success and failure situations

Participants self-rated their computer skills on Likert scales ranging from 1 (low) to 7 (expert) in the various categories: Operating Systems (M = 5.58), Internet (M = 6.42) and Applications (M = 5.89). Participants reported a total of 159 situations (on average 8 per person). 78 were successes (on average 3.9 per person) and 81 (on average 4.0 per person) failures. 93 of all situations were reported in the workplace and only 66 in private circumstances.

Success. All attributional dimensions are only moderately inter-correlated, thus supporting the construct validity of the research instrument.

Just as in study 1, three clusters could be identified for attribution of success (Fig. 3). Clusters G "*Humble*" (with slightly lower values than study 1) and I "*Realistic*" were identical with the clusters in study 1. Cluster H ("*Lucky guy*" – "Everything I do turns out right") had also been found in previous investigations [7]. Persons in this cluster see reasons for success internally, they feel more in control than persons from cluster A and have the highest values concerning stability and globality, thus displaying a sense of faith that things will simply go right.

Table 4 shows the mean values for the clusters. ANOVAs were calculated showing significant differences between clusters in all dimensions except for controllability. Effect sizes are high, also except for controllability [12].

Failure. The attributional dimensions are only moderately inter-correlated (merely controllability and globality correlate at r = 0.57).

For failure situations, cluster analysis identified three clusters (Fig. 3). Cluster K ("*Resigned*") is identical with results from study 1 and already described in Sect. 3. Even though Cluster L ("*Confident*") looks different at first glance, this cluster represents a typical "*Confident*" attribution style: Persons in this Cluster have the highest

Table 4. ANOVA results for success clusters

Cluster	G n = 10	H n = 7	I n = 3	F value	p	η^2
Locus	4.69	1.55	2.50	47.619	<0.000***	0.849
Stability	5.71	6.48	3.11	13.080	<0.000***	0.606
Controllability	3.63	3.28	1.92	1.263	0.308	0.129
Globality	5.54	6.05	3.42	4.660	0.024*	0.354

internality values and feel responsible for their failure, but also feel in control of the situation. Cluster J ("*Shrugging*" – "Every failure is unique") had also been found in one of the pilot studies [7]. Persons from Cluster J have medium values in all dimensions; they believe that different situations have unique causes.

Again, ANOVAs were calculated showing significant differences between clusters. Effect sizes are high (Table 5).

Table 5. ANOVA results for failure clusters

Cluster	J n = 14	L n = 4	K n = 2	F value	p	η^2
Locus	5.52	5.96	2.83	7.740	0.004**	0.477
Stability	5.83	6.15	2.67	7.711	0.004**	0.476
Controllability	3.94	5.58	1.50	23.741	<0.000***	0.736
Globality	5.18	2.25	4.83	8.266	0.003**	0.493

5 Study 3 – Using Attribution Questionnaires in Usability Tests

5.1 Research Methodology

In this study we investigated computer-related attribution styles as part of different usability tests that were conducted in our laboratory, covering a range of different applications (e.g. online rail-ticket booking system, stock price websites, news websites). After completing the usability tests, participants were asked whether success or failure had occurred during the test and were shown the respective parts of the attribution questionnaire described in Sect. 2. It was up to the participants to decide whether, and–if so–how many successes or failures had taken place in the usability test (up to 3 each could be reported).

5.2 Results

In all, 32 persons participated in the study (22 % female, 78 % male). Mean age was 27.42 years (range: 21–64 years). The general level of education was quite high (94 % with high school or university degree). On average they had 16 years (range: 8–22 years) of experience in private computer use and 12 years (range: 4–22 years) experience using computers at school or in the workplace. Participants self-rated their computer skills on Likert scales ranging from 1 (low) to 7 (expert) in the different categories: Operating Systems (M = 5.79), Internet (M = 6.12) and Applications (M = 5.73). Participants reported a total of 107 situations (68 success situations (M per Person = 1.56; range 0–3) and 39 failure situations (M per Person = 0.5; range: 0–2)).

Success. In this study, we found higher inter-correlations of the attributional dimensions: Locus and controllability correlate at r = 0.45. Stability and globality correlate at r = 0.72 and controllability and stability correlate at r = 0.42.

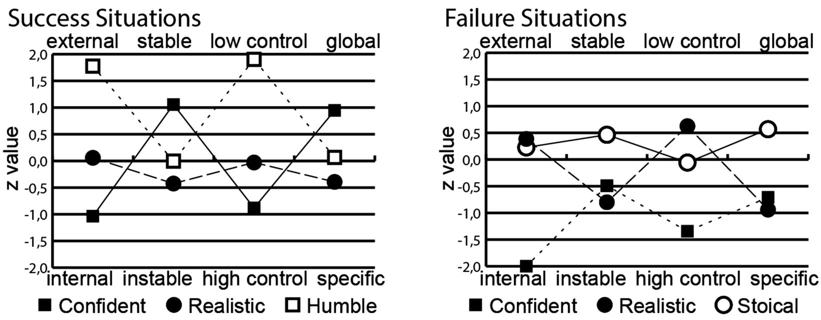

Fig. 4. Clusters for success and failure situations

For success situations, cluster analysis identified the three clusters "*Realistic*", "*Confident*" and "*Humble*" (Fig. 4). Thus, results were identical with the laboratory study described in Sect. 3.

Table 6 shows the mean values for the clusters. ANOVAs were calculated showing significant differences between clusters. Effect sizes are high [12].

Table 6. ANOVA results for success clusters

Cluster	M n = 20	N n = 8	O n = 4	F value	p	η^2
Locus	3.28	1.65	5.83	31.610	<0.000***	0.686
Stability	5.63	6.94	6.00	9.836	0.001**	0.404
Controllability	2.87	1.38	6.25	29.229	<0.000***	0.668
Globality	5.32	6.81	5.83	7.167	0.003**	0.331

Failure. Regarding inter-correlations, again stability and globality correlate at r = 0.73 and locus and controllability correlate at r = 0.46.

For failure situations, cluster analysis identified the previously known clusters of P "*Realistic*" and R "*Confident*" as well as a new cluster we termed "*Stoical*" (Fig. 4). Compared to previous studies, however, persons in Cluster P had lower values in the control dimension. Cluster Q constitutes a new style not previously found in any of the other studies. Persons from Cluster Q ("*Stoical*" – "It's all the same over and over again") have high values regarding stability and globality, and medium values regarding locus and controllability. Thus, they perceive persistent causes of failures over time or in different situations while displaying a similar sense of controllability and internality as the "*Realists*".

Again, ANOVAs were calculated showing highly significant differences between clusters. Effect sizes are high (Table 7).

Table 7. ANOVA results for failure clusters

Cluster	P n = 8	Q n = 17	R n = 3	F value	p	η^2
Locus	6.00	5.71	1.00	25.461	<0.000***	0.671
Stability	4.19	6.15	4.67	6.795	0.004**	0.352
Controllability	5.69	4.29	1.67	5.847	0.008**	0.319
Globality	2.56	5.44	3.00	13.589	<0.000***	0.521

6 Study 4 – Retrospective Online Survey

6.1 Research Methodology

In this study computer-related attributions were measured by means of a retrospective online questionnaire. Participants were asked to remember their latest computer-related situations of success and failure and fill out the attribution questionnaire while reconsidering these experiences. The call for participation was distributed virally via e-mail and social networking sites.

6.2 Results

In all, 90 persons participated in the study. We included only completed questionnaires into data analysis that contained one situation of success and failure (n = 30, 32 % female and 68 % male). Mean age was 28 years (range: 20–45 years). The general level of education was quite high (80 % with high school or university degree). On average they had 14.4 years (range: 5–21 years) of experience in private computer use and 10 years (range: 0–21 years) experience using computers at school or in the workplace. Participants self-rated their computer skills on Likert scales ranging from 1 (low) to 7 (expert) in the different categories: Operating Systems (M = 5.97), Internet (M = 6.27) and Applications (M = 5.60). Participants reported a total of 60 situations (30 success situations and 30 failure situations).

Success. As was observed in study 1, only stability and globality correlate at r = 0.50.

In this study only two clusters appeared for situations of success: "*Realistic*" and "*Confident*" (Fig. 5). Both of them have already been described in the previous sections.

Table 8 shows the mean values for the clusters. ANOVAs were calculated showing significant differences and high effect sizes regarding locus and globality [12]. Differences regarding stability and controllability are not significant.

Failure. Regarding inter-correlations, locus and stability correlate at r = 0.58 and stability and globality correlate at r = 0.71.

In situations of failure three clusters could be identified (Fig. 5). The clusters "*Resigned*" and "*Confident*" were identical with previous studies. Furthermore, the "*Stoical*" style newly identified in study 3 was also present in this study.

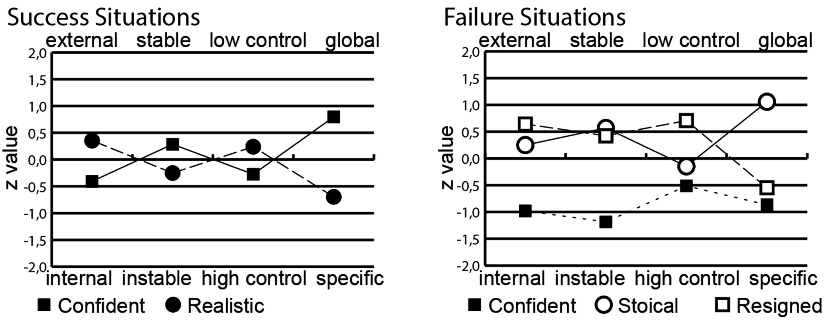

Fig. 5. Clusters for success and failure situations

Table 8. ANOVA results for success clusters

Cluster	S n = 16	T n = 14	F value	p	η^2
Locus	3.81	2.43	4.891	0.035*	0.149
Stability	5.44	6.29	2.252	0.145	0.074
Controllability	2.63	1.79	2.042	0.164	0.068
Globality	3.13	6.50	37.651	<0.000***	0.573

Compared to previous studies, persons from Cluster U ("Resigned" – "I never understand what computers do") show lower values regarding globality. This was also observed in the diary study and might be due to the method of data collection.

As for success situations, ANOVAs were calculated showing significant differences between clusters. Effect sizes are high (Table 9).

Table 9. ANOVA results for failure clusters

Cluster	W n = 9	V n = 12	U n = 9	F value	p	η^2
Locus	6.33	5.50	2.89	11.094	<0.000***	0.451
Stability	6.33	6.67	2.67	22.466	<0.000***	0.625
Controllability	5.78	3.83	3.00	4.405	0.022*	0.246
Globality	2.44	6.42	1.67	50.767	<0.000***	0.790

7 Discussion

7.1 Interpretation of Results and Resulting Typology

The goal of this paper was to validate and refine the typology of computer-related attribution styles (cf. Fig. 1) that had been developed in two pilot studies [7] and to investigate whether these styles are reproducible through the use of different methods of data collection. To this end, four elaborate studies with a total of N = 146 participants were conducted (see Table 10).

Table 10. Comparison of results of the four Studies.

	Study 1 lab	Study 2 diary	Study 3 usability	Study 4 QN
Total response N	66	78	46	90
Valid response N	58	20	32	30
Female %	46.9	52.6	21.9	32.1
Male %	53.1	47.4	78.1	67.9
Age, M, years	38.2	34.32	27.42	28.37
Range	17–75	19–74	21–64	20–45
Education, M (Scale: 1 no educational degree – 7 university degree)	4.77	6.26	6.12	5.97
Computer experience in years (private)	12.36	14.95	15.67	14.4
Range	0–21	7–21	‘8–22	5–21
Computer experience in years (work)	10.21	11.42	10.97	10.23
Range	0–21	0–21	4–22	0–21
Daily computer use in hours (private)	2.45	2.53	4.33	3.48
Range	0–21	0–6	1–10	0–15
Daily computer use in hours (work)	3.7	4.26	6.12	3.9
Range	0–10	0–9	1–11	0–14
Self-assessed computer skills OS, M (Scale: 1 low – 7 expert)	4.17	5.58	5.79	5.97
Self-assessed computer skills Internet, M (Scale: 1 low – 7 expert)	4.98	6.42	6.12	6.27
Self-assessed computer skills applications, M (Scale: 1 low – 7 expert)	3.66	5.89	5.73	5.6
Total situations	**387**	**159**	**107**	**60**
Situations of success	197	78	68	30
Situations of failure	190	81	39	30

The four studies comprised a *laboratory study* explicitly evoking situations of success and failure by giving participants solvable and non-solvable tasks (Sect. 3), a *mobile diary study* where participants reported real use situations over a period of several weeks (Sect. 4), a study investigating computer-related attribution styles in various *usability tests* (Sect. 5), and a *retrospective online survey* asking participants to remember their last computer-related situations of success and failure (Sect. 6).

To sum up, results of the four studies confirm the typology of computer-related attribution styles that had been developed in the pilot studies [6]. Even though very different methods of data collection were used, the same attribution styles emerged over and over again, thus supporting the assumption that people indeed display stable, specific computer-related attribution styles.

Overall, a total of ten attribution styles were identified (five of them related to success or failure situations, respectively). While all styles described in the pilot studies could be reproduced except for one (“*The Boss*”, see Fig. 1), a new style, called the

"*Stoical*", emerged in the usability study (study 3) as well as the retrospective survey (study 4). The refined typology resulting from our studies is shown in Table 11. The numbers indicate how often the specific style appeared in each study.

As can be seen from this overview, especially six styles emerged in almost all studies: In situations of success, these styles include "*Realistic*" (41.29 %), "*Confident*" (27.36 %) and "*Humble*" (24.38 %); in situations of failure, "*Confident*" (25.98 %) "*Resigned*" (23.04 %) and "*Realistic*" (17.16 %) reappear the most frequently. (Also, the "Shrugging" style was among the most frequent, however it emerged in only one of the four present studies. Furthermore, the "Realistic" style is more expressive regarding the behaviors associated with it).

Among the finally chosen, the "Confident" styles can be seen as *favorable* attribution patterns, as these persons experience ample control when working on computer-related tasks and feel confident to handle even difficult situations. On the other hand, the "Humble" and "Resigned" styles can be seen as *unfavorable* styles: People with these attributional patterns feel that success or failure are due to external factors and there is little they can do to change the situation – a pattern of helplessness. The "Realistic" styles are situated in between these extremes: Neither overly confident nor overly pessimistic.

Table 11. Refined typology of computer-related attribution styles

		Pilot Studies [6]		*Studies 1-4*				
	Style	*Diary*	*QN*	*Lab*	*Diary*	*Usability*	*QN*	*%*
Success	**Realistic**	3	20	21	3	20	16	41.29
	Humble	2	11	22	10	4		24.38
	Lucky guy	1			7			3.98
	Confident	3	15	15		8	14	27.36
	The Boss		6					2.99
Failure	**Realistic**		12	15		8		17.16
	Shrugging	7	19		14			19.61
	Confident	1	11	27	2	3	9	25.98
	Resigned	3	15	16	4		9	23.04
	Stoical					17	12	14.22

In our view, these main styles especially deserve attention in further HCI research. To utilize them in design processes, we developed *personas*, which are described in Sect. 7.3.

7.2 Methodical Discussion

Another aim of our research was to compare different methods of investigating computer-related attribution styles. As all methods – laboratory tests as well as field studies and online surveys – yielded very similar results we conclude that a wide range of research methods can be utilized for attribution research. In the following paragraphs the advantages and drawbacks of the different methods and differences in terms of the attribution styles emerged with each method are discussed.

Laboratory studies usually require a rather high effort for preparation and conduction of the tests. They also require some time and effort by the participants, who need to show up at a certain time and place. One big advantage, on the other hand, is the high completion rate, as participants usually work under supervision of the experimenter. Standardized use situations create a very similar experience for all participants. Therefore, this was a valuable method to explore computer-related attributions in an early stage of this research. The drawback, however, is that the situations are somewhat artificial and unrelated to the participants' normal use habits, which might result in reduced intensity and significance of the experience. Nonetheless, the laboratory study was the only method that yields no more or no less than the six main attribution styles. Furthermore, an interesting finding is that in this study in situations of failure the "Confident" style (47 %) emerged the most often (compared to the other studies) even though participants had less computer experience, less self-assessed skills and used computers less frequently than the participants in the other studies. Whether this finding is related to the method as such or to other factors cannot be clearly answered.

As an alternative, including attribution questionnaires in *usability studies* also turned out to be a very feasible way of data collection. Short scales measuring the four attribution dimensions like the ones we used could be easily included in usability tests to systematically measure attributions. Of course usability tests might also be conducted outside the laboratory. Concerning the attribution styles in situations of success the "Realistic" (63 %) style appeared most often compared to the other studies. Unlike the laboratory study the gender distribution was not balanced (78 % male). Maybe men show the "Realistic" style more often, as this was also the case in the questionnaire study (53 % Realistic style, 68 % male). Furthermore, a new style–the "Stoical"–emerged in both studies. Again, this might be a style especially shown by younger men.

The main advantage of *diary studies* in general is that the participants record real situations in a prompt and detailed manner [7, 13, 14]. However, participants need to be highly motivated to actually keep their diary for a longer period of time and remind themselves to record relevant situations in a timely manner during their everyday activities, when they have other more important things to do. As a result, dropout rates are usually very high [13, 14].

In our study we used a digital diary application – a web app to be used on desktop and mobile devices, which was specifically tailored to our attribution questionnaire. The goal was to make it easier for participants to record their experiences, e.g. using their smartphones when on the way. However, developing such an application requires a long preparation time, quite some considerable effort and relatively high costs. Furthermore, some interference between the subject of evaluation and the method of data collection occurred: Some participants reported technical problems with the diary application and were, therefore, not motivated to carry on with the diary. In the end, a simple paper-based diary might be a better choice, making it both easier for participants to record their use experiences and causing less effort for researchers. In any case it is notable that compared to the pilot study, when a paper-based diary had been used, neither participation nor dropout rates were lower than in our present study using a mobile diary application [cf. 7]. In comparison to the other studies, in situations of success the "Confident" style did not emerge in the mobile diary studies. Instead, we found the "Lucky guy" style, which also appeared in the paper diary study. Likewise, in situations of failure both diary studies show the "Shrugging" attribution style. These differences might be due to the fact that in diary studies people report everyday use situations: Possibly, the perception of everyday situations differs from given tasks or situations. It would be interesting to investigate whether the "reality" of a situation influences attribution styles.

Using an *online survey* is a fast, low-cost and easy method to measure attribution styles for both experimenters and participants, giving them the freedom to attend the survey at almost any time and in any location. In the pilot study, a different questionnaire had been used, presenting participants with fictive scenarios of computer-related successes and failures and asking them to envision these situations. Several participants commented afterwards that the situations had appeared artificial to them and they found it difficult to relate to them.

Therefore, in the present online study we took a different approach and asked participants to remember their last computer-related situations of success and failure. While the advantage is that they reported real use situations, a possible drawback is that recalling attributions after some time has elapsed may result in distorted perception [15]. This might also explain that an additional cluster emerged from the data in situations of failure, while only two clusters could be replicated in situations of success. In situations of failure, persons with a "Resigned" attribution style also refer the cause for their failure to a specific situation just like in the diary study, possibly indicating that "real", spontaneous situations differ from more "artificial", given tasks. Nevertheless, the results are mainly comparable with the other studies, so overall we hold this to be a feasible method to investigate computer-related attributions.

The completion rate in this study was 30 %. While this is a common value for online studies, it is striking that most participants dropped out at the item asking for a short description of the last computer-related situation of success. We suspect that participants found this too tedious and time-consuming to fill out. We included this item to understand the users' experiences better and to be able to investigate possible relations between use context and attribution styles [cf. 16]. However, to encourage more participation it might be feasible to do without this item or offer participants a list of more generic descriptions to choose from (e.g. "related to operation system", "web application" etc.).

In this paper we cannot clearly answer the question whether the differences in attribution styles in different studies are related to the method of data collection or to other factors concerning the sample composition (e.g. age, gender, experience, skills). However, further analyses of the data indicate that socio-demographic factors play a role [16]. It would be interesting to use these methods on one sample group in future investigations to make the differences clear.

7.3 Implications and Future Work

The typology of computer-related attribution styles can be used in HCI research and practice to understand better why users think, feel, or behave in a certain way. It is easy to imagine that a "humble" user will behave differently than a "confident" user and thus might react differently to system design [17]. Thus, design principles could be developed to support different types of users in a specific way. Furthermore, including attribution styles as personal traits in usability studies could help to understand and interpret results: E.g., the number of bugs reported could be related to attribution styles, or participants with more unfavorable styles will probably experience more stress during usability studies

To make the typology of attribution styles more applicable especially for HCI practice, we developed *personas* (Fig. 6 for situations of success and Fig. 7 for situations of failure) to represent the six most central styles (see Sect. 7.1).

Personas are vivid descriptions of fictive yet characteristic user types that can be used in usability engineering processes to envision the future users of an application and keep their needs, attitudes, and prerequisites in mind [18]. Thus, the "attributional personas" are a tool for designers to envisage users with distinct approaches that they are very likely to encounter in later use practice. It should be noted that due to limited space only male personas are pictured here. We are currently developing an extensive set of personas representing both men and women, different age groups, educational backgrounds etc.

Fig. 6. Personas for central attribution styles in situations of success.

Fig. 7. Personas for central attribution styles in situations of failure.

In our research we are currently investigating the relation of *socio-demographic* variables such as age, gender, computer mastery etc. with attribution styles [16]. Furthermore, we are interested to investigate whether attributional styles influence *system evaluations* in usability tests. To that end, we are conducting further analyses of the usability data collected in study 3. As a long-term perspective, we seek to develop *design principles* to support users with different attribution styles with tailored system responses.

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