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GOOD, BAD, OR BOTH? MEASUREMENT OF PHYSICIAN'S AMBIVALENT ATTITUDES TOWARDS AI

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Research paper

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Abstract

Artificial intelligence is currently one of the most controversial discussed technologies across various work domains. In healthcare, AI fosters widespread positive beliefs of substantially increasing the quality of care, yet evoking physicians' fears of being marginalized or replaced. The described controversy leads to ambivalent attitudes, as physicians hold both strong positive and negative evaluations at the same time. However, current research in information systems has not been able to measure ambivalence because uni-polar attitude scales cannot assess this construct. Additionally, it is unclear whether ambivalence has positive or negative consequences and how it is related to resistance to change. In the context of AI in healthcare, we conducted a survey study (n=74) to measure context-specific attitudes and attitude ambivalence of physicians. We distinguish between two states of ambivalence and show that physicians who experience an inner conflict (Felt Ambivalence) from conflicting attitudes (Potential Ambivalence) develop resistance to change. Moreover, including ambivalence into a regression model explains more variance than uni-polar attitudes alone. With this research, we show that ambivalent attitudes can be measured in the context of technological change. Additionally, we explore how context-specific attitudes towards AI in healthcare drive physicians' ambivalence towards it.

Keywords: Ambivalence; User Attitudes; Resistance; Artificial Intelligence; Healthcare IT

Introduction

Current trends in healthcare, such as the personalization of medicine, demographic change and budget cuts, cause higher workloads for physicians. Although currently the digitalization of healthcare is in its very beginning, artificial intelligence as a medical decision aid is gaining momentum. Intelligent clinical decision support systems (ICDSS) such as IBM Watson have been able to attract considerable attention. ICDSS support medical decision-making concerning diagnostics and treatment decisions. These developments not only raise expectations for novel opportunities but also fears of getting marginalized. They are strongly debated among (younger) physicians since they will have a vast impact on their profession. Doctors fear that they become dependent and/or dispensable in patient treatment processes for the sake of increasing the medical precision, quality and efficiency (Fazal et al., 2018; Jha and Topol, 2016). Therefore, the upcoming transition through ICDSS is likely to cause both, strong positive and negative internal states for medical doctors and, thus, a profound state of ambivalence.

However, there is no consensus in the literature on the consequences of this ambivalence on technological change processes. On the one hand, highly ambivalent individuals were, for example, noted to

exhibit increased interpersonal adaptability and openness to change (Plambeck and Weber, 2009). They are also more likely to engage in higher levels of information seeking and balanced information processing by taking into account multiple perspectives on the issue (Rothman et al., 2017). On the other hand, ambivalence can invoke behavioral paralysis due to increased uncertainty and rumination (Emmons and King, 1988; Rothman et al., 2017). Moreover, it can incite various forms of resistance to change as such defensive reactions, non-cooperative behaviours, amplified behavioural inertia through maintaining old work practices (Vince and Broussine, 1996), voicing negative opinions, resignation, or even active resistance (Piderit, 2000; Rothman et al., 2017). Yet, extant research argues that successfully coping with ambivalence is an important step towards adapting to (technological) change (Stein et al., 2015; Van Harreveld et al., 2015). Thus, it is essential to understand how ambivalence develops and which consequences it has in order to tackle potential ambivalent users in a early change process.

Only few studies in information systems explicitly address ambivalence (see e.g. Moody et al., 2017) mostly because measures of attitudes in information systems are not able to fully capture ambivalence due to two major reasons (Jensen and Aanestad, 2007). First, the models of technology adoption such as the Technology Acceptance Model (TAM) or the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003) only capture positive cognitive evaluations of technology. Cenfetelli and Schwarz, (2011) demonstrated that negative cognitive evaluations have a separate effect as inhibitors. Yet, the combination of both high positive and high negative attitudes remains unexplored (Moody et al., 2017). Second, when asking participants to rate perceptions and attitudes on univalent scales, a neutral score can conceivably mask the existence of two distinct and fundamentally different attitudinal subgroups: being indifferent or highly ambivalent. In other words, the neutral point of the scale is most likely to be marked by both, those who simply do not care and those who cannot decide because they are torn between both sides (Van Harreveld et al., 2009).

To address these gaps, we aim to understand and conceptualize the nature of ambivalent attitudes and their impact on change processes. Ambivalence is highly contextual as it is caused by topical, strongly discussed, socially controversial issues (Thompson et al., 1995). Therefore, we have chosen ICDSS as a focal technology and healthcare as a specific research context (Burton-Jones and Volkoff, 2017; Hong et al., 2014). In healthcare, physicians have higher tendency for maintaining the status quo than other professional groups and are therefore prone to resist change. This is considered as an important antecedent of not adopting information technologies (Bhattacherjee and Hikmet, 2007; Lapointe and Rivard, 2011). Thus, understanding the impact of ambivalence on resistance to change has high importance in healthcare. Therefore, we aim to answer the following research questions:

1) *How can ambivalent user attitudes towards ICDSS be conceptualized and measured?*
2) *How does ambivalence impact resistance to change?*

Our study seeks to contribute (1.) to the current discussions on IS contextualization (Alvesson and Kärreman, 2007; Burton-Jones and Volkoff, 2017; Hong et al., 2014) by measuring ambivalence in a specific usage and technology context and (2.) to the social patterns regarding the implementation of artificial intelligence as a decision aid in healthcare (Kohli and Tan, 2016). Furthermore, this research contributes to (3.) the theoretical understanding of ambivalence by investigating how upcoming technological change causes ambivalence and what consequences it has on resistance to change. Our research offers important insights that healthcare practitioners should consider when introducing artificial intelligence based systems into the healthcare context.

1 Attitudinal Ambivalence

2.1 Attitudes

Attitudes are defined as "an overall evaluation of an object that is based on cognitive, affective, and behavioural information" (Maio and Haddock, 2014). Generally, "anything that is discriminable or held in mind, sometimes below the level of conscious awareness, can be evaluated and therefore can

function as an attitude object" (Eagly and Chaiken, 2007, p. 583). Attitudes can differ in their valence, i.e., whether they are positively or negatively directed, as well as in their strength (Maio and Haddock, 2014). An individual's attitude constitutes a summary (or expression) of three components, i.e., the held beliefs or thoughts (cognitive component), feelings and emotions (affective component) and past, present or intended behaviours (behavioural component) towards the attitude object (e.g., Eagly and Chaiken, 1993). The three attitude components are "(usually) consistent in their evaluative implications" and of "synergistic relation", yet they are distinct in quantity and quality quantitatively, meaning that they can differ in valence and strength as well as in how they contribute to the overall attitude (Maio and Haddock, 2014).

2.2 Ambivalence

Traditionally, attitudes have been regarded as bipolar, dichotomous, or univalent, i.e., being either positive, negative or neutral towards an attitude object (Thompson et al., 1995). Contemporary social-psychologists, however, have increasingly challenged this model and proposed a reconceptualization towards a bi-dimensional view of attitudes including the idea of ambivalence (Armitage and Conner, 2004). Ambivalence can have both an indirect and direct influence on dependent variables because it is often considered to influence the strength of attitudes and the relationship between attitudes and behaviour (Sawicki and Wegener, 2018). Ambivalence rests on the observation that individuals can "simultaneously hold positive and negative attitudes that are not perfectly (negatively) correlated with one another" (Armitage and Conner, 2004). In other words, an individual can at the same time, hold strong negative and positive evaluations towards the same attitude object (Conner and Sparks, 2002).

Moreover, contemporary ambivalence literature has further stated two necessary conditions of ambivalence (Thompson et al., 1995). The first one is that attitudes should be as similar in magnitude as possible (i.e., both similarly high or similarly low). As the disparity in magnitude among the two evaluations increases, the individual favours the direction of the stronger uni-polar evaluation (Thompson et al., 1995). That means, that individuals develop either strong positive or strong negative attitudes. The second condition states that these ambivalent evaluations should have at least a moderate intensity (Thompson et al., 1995). This differentiates ambivalence from indifference. Hence, as long as two conflicting attitudes are similar in their strength, ambivalence increases with intensity of both attitudes (Thompson et al., 1995). In other words, the most ambivalent individuals hold simultaneously strong, opposing evaluations. For instance, artificial intelligence can be evaluated by physicians as strongly positive because of its benefits for patient care and as strongly negative because it affects current work practices. As long as physicians hold both perspectives with similar strength, ambivalence remains. But, if the negative aspects of ICDSS increase due to, for example, changes in work practice through an ongoing technology implementation, ambivalence is replaced by univalent attitudes.

2.3. States of Ambivalence

Due to the complex nature of ambivalence, a consensus among researchers on the measurement of ambivalence has not yet been achieved. One prominent distinction, which has been widely utilized in prior studies, is between Potential Ambivalence (PA) (e.g., Kaplan, 1972) and Felt Ambivalence (FA) (e.g., Priester and Petty, 1996). PA relates to the pure existence of simultaneous positive and negative evaluations, i.e., a structural state of attitudes. There are two categories of PA, intracomponent and intercomponent ambivalence (Maio and Haddock, 2014). Intracomponent ambivalence refers to a state in which a person simultaneously holds both strong negative and positive beliefs, also regarded as cognitive ambivalence and/or experiences both strong negative and positive feelings, i.e., affective ambivalence, towards an attitude object (e.g., Abelson et al., 1982). For example, physicians may evaluate the increase in decision security achieved through using ICDSS as positive, but at the same time they may evaluate the potential for legal issues as highly negative. As long as both positive and negative cognitions or emotions remain equally strong, PA is present (Van Harreveld et al., 2009). If one direction becomes dominant, ambivalence vanishes and is replaced by univalent attitudes being either favourable or opposing the system. The second form of PA is intercomponent ambivalence. This

form relates to inconsistencies between the valence of different attitude components. This can either be manifested in simultaneous negative beliefs and positive feelings, i.e., cognitive-affective ambivalence, or in simultaneous positive beliefs and negative feelings, i.e., affective-cognitive ambivalence (Lavine et al., 1998). For example, physicians may experience a feeling of job threat from the introduction of ICDSS in combination with high perceived benefits for the patient care. This would be a conflict between the cognitive component (positive thoughts) and the affective component (negative emotions). It is typically assumed that PA can be implicit and individuals can not be aware of it (Van Harreveld et al., 2009).

Construct	Definition	Reference
Attitudes	An overall evaluation of an object that is based on cognitive and affective information.	(Maio and Haddock, 2014)
Felt Ambivalence (FA)	The subjective experience of feeling torn between conflicting attitudes.	(Van Harreveld et al., 2015), (Priester and Petty, 1996)
Potential Ambivalence (PA)	Simultaneous existence of conflicting attitudes either within one or between multiple components.	(Van Harreveld et al., 2015), (Thompson et al., 1995)

Table 1. Overview of States of Ambivalence

By contrast, FA relates to the individual's subjective "experience of evaluative conflict, including a sense of being conflicted, confused, torn, and mixed" (DeMarree et al., 2014, p. 6) towards an attitude object. It can result in mixed reactions such as conflicting feelings or indecision. In other words, FA refers to the extent to which the individual emotionally experiences an inner conflict from conflicting attitudes.

The relationship between PA and FA is strongly disputed in current ambivalence research and in particular FA is considered to be under-researched (e.g., Armitage and Arden, 2007). Given that some research results indicate only moderate correlations between PA and FA (Armitage and Arden, 2007), it is suggested "that ambivalence can either be salient (leading to an affective response) or remain in a dormant (and exclusively structural) state" (Van Harreveld et al., 2015). In line with this, it is often argued that FA arises only if the inner conflict (i.e., PA) is made salient and both sides of the conflict are relevant to the individual. This makes PA the antecedent of FA (Van Harreveld et al., 2015). For example, physicians may in fact be aware of conflicting attitudes concerning ICDSS, but may not be irritated by them, because they believe it is unlikely for them to be affected by ICDSS. In this case, the inner conflict would continue to be merely a potential conflict. For example, a hospital would introduce a new mandatory ICDSS for all oncologists. Suddenly, physicians who previously only had potential ambivalence are confronted with their inner conflict and feel torn between positive beliefs and emotional anxiety. That means that inner conflict is no longer dormant, but is salient and relevant causing the decision to use/not to use the system. Thus, FA can be considered the underlying mechanism behind resistance behaviours (DeMarree et al., 2014) as individuals are motivated to reduce their inner conflict and the psychological discomfort (Van Harreveld et al., 2009). Table 1 provides an overview of the different states of ambivalence.

2.4. Review of Ambivalence Research in Information Systems

While the topic of ambivalence is object to various research in psychology (Van Harreveld et al., 2015) and management (Rothman et al., 2017), it has received little attention in information systems. Yet, some studies mention ambivalence scarcely with respect to various types of information systems (Corbitt, 2000; Tsai et al., 2017; Van Offenbeek et al., 2013; Young et al., 2012) and also with regards to healthcare IT. For instance, as a result of their case study on the reactions of orthopaedic surgeons towards the adoption and mandatory use of an electronic patient record system, Jensen and Aenestad (2007) concluded ambivalence to be a "striking feature" (p. 678). Similarly, the case study by (Van Offenbeek et al., 2013) on a telecare implementation project identified ambivalent behaviour among care givers and management personnel. Throughout their qualitative case study, Stein et al. (Stein et

al., 2015) observe that participants who held ambivalent affective responses towards the system engaged in a mixture of different adaptation behaviours, as opposed to one specific strategy, resulting in non-conforming support patterns. Building on Stein et al. (2015), the research by Tsai et al. (2017) concludes with the hypothesis of ambivalent users engaging in non-conformative use behaviour or no use at all. The majority of studies are considering ambivalence use together with qualitative approaches and only two studies, Moody et al. (2017) and Turel (2015) quantitatively measure ambivalent attitudes with regards to trusting and distrusting intentions as well as continuance and discontinuance intentions of hedonistic IT use. Yet, neither of these studies differentiate between PA and FA. Overall, only few IS researchers targeted the topic of ambivalence and even less of them investigated it applying quantitative research methods.

2.5. Research Model and Hypotheses

In light of the existing gaps in the literature, we aim to explore if and how evaluations of ICDSS cause ambivalence and how its influence on resistance to change may be conceptualized and measured. We follow the literature to conceptualize PA as an antecedent of FA and develop the following research model in Figure 1.

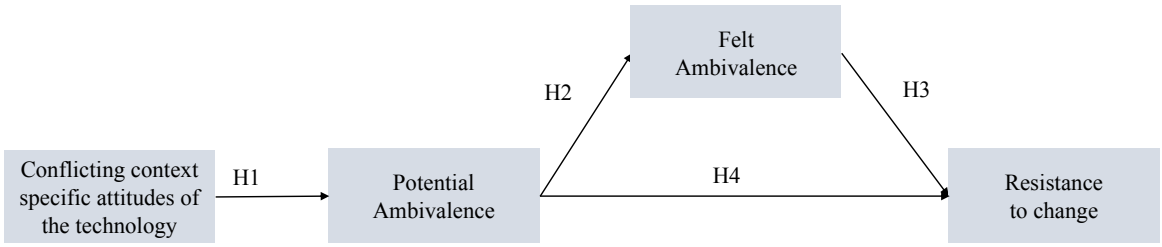

Figure 1. Research model and hypothesis

Using artificial intelligence to support decision-making in medicine is a highly controversial issue which causes multiple discussions about the benefits and risks which in turn can cause PA (Thompson et al., 1995). Particularly, using AI for decision support might reduce physicians' autonomy in decision making, but at the same time provide benefits for patient care. These conflicting attitudes are likely to evoke PA. Thus, in line with prior research we propose: *Conflicting context-specific attitudes cause PA (H1).*

Furthermore, we propose that the resulting conflicting evaluations accumulate for some individuals into a feeling of inner conflict (FA) causing negative affect as both positive and negative sides are experienced. Thus, we consider PA to be an antecedent of FA (Van Harreveld et al., 2015). Based on this, we hypothesize: *A higher degree of PA results in more FA (H2).*

Furthermore, FA induces an experience of psychological discomfort (Van Harreveld et al., 2015) which can lead to behavioural inflexibility, avoidance, or resistance to change (Rothman et al., 2017). Furthermore, a higher degree of felt ambivalence is a negative affective state which individuals aim to reduce. Because ICDSS are not implemented in clinical practice yet, physicians with high FA can reduce this state only by avoiding the confrontation with ICDSS, as other mechanisms of coping (Stein et al., 2015) are not available. Furthermore, especially in the pre-implementation phase, the desire for maintaining the status quo, i.e. resistance to change, functions as an antecedent of technology adoption (Bhattacherjee and Hikmet, 2007), which has to be first overcome before the introduction of new technology is successful. Thus, we hypothesize: *Higher degree of FA results in higher resistance to change (H3).*

In addition, we propose that FA fully mediates the effect of PA on resistance to change. This means, that physicians only develop resistance to change through ambivalent attitudes if they experience psychological discomfort (DeMarree et al., 2014). This is in line with current research on the relationship between PA and FA as FA being the manifestation of PA. Hence, in line with RQ2, we propose: *FA mediates the effects of PA on resistance to change (H4).*

Lastly, beyond the described research model, we propose that including two states of ambivalence as determinants of resistance to change will add significant value compared to previous conceptualizations of attitudes as univalent. To measure ambivalence, it is not enough to sum up positive and negative attitudes. Instead, these two sides must be equally relevant and present for the individual. This means that the state of ambivalence differs distinctly from univalent attitudes and that by considering positive and negative attitudes alone, those who hold ambivalent attitudes are not captured. Accordingly, we propose that *ambivalence has an additional contribution to the clarification of variance in resistance to change beyond the influence of negative and positive attitudes alone* (H5).

2 Research Design

3.1. Research Context

To investigate our research questions, we have chosen a distinct ICDSS in healthcare for our research context. The implementation of decision support systems in healthcare is closely linked with the perception of medical doctors as decision makers (Berg, 1997). Therefore, implementing or using decision support systems in healthcare is not only a matter of technology but more a matter of the identity of the medical profession. The perceived impact on status, expertise, autonomy and patient care are important factors to consider when implementing technology in this context (Jussupow et al., 2018). Currently, artificial intelligence is the subject of severe controversial discussions among healthcare professionals. In the medical field, benefits, such as improving patient treatment outcomes by better and faster diagnosis, are mentioned side by side with negative consequences, such as doctors being replaced by AI (Fazal et al., 2018; Jha and Topol, 2016). Moreover, the discussion has become highly emotional as the technological development is currently heavily enforced in the healthcare domain, but the exact consequences are still unknown. Therefore, this context offers a unique research opportunity for understanding how ambivalence is formed because it is considered to frequently occur in line with socially controversial issues (Thompson et al., 1995). For our study, we applied a vignette of IBM Watson System of Oncology describing the functionalities and capabilities of IBM Watson (Jussupow et al., 2018). IBM Watson is a system that is said to automatically derive diagnosis and treatment recommendations by inferring from electronic health records and from processing the notes of physicians (Doyle-Lindrud, 2015). This system has been strongly marketed by the vendor, emphasized in the professional press and is therefore well known by physicians.

3.2. Method and Measures

In order to test our developed hypotheses, we use a three-stage hierarchical linear regression model with resistance to change as our dependent variable. Throughout the paper, we define the construct resistance to change (RC) as the preference of the status quo and as opposition to change (Bhattacherjee and Hikmet, 2007). In order to measure the participants resistance attitudes a four items measure by (Bhattacherjee and Hikmet, 2007) was utilized. Each item was assessed via a 5-point Likert-scale.

The measure of PA consists of a combined measure of overall attitudes towards the use of artificial intelligence, the cognitive beliefs and the affective evaluation. For every evaluation (overall opinion, thoughts, and emotions), participants were asked to separately indicate their degrees of positive (P) and negative (N) evaluations, each on a four-point split semantic differential scale, anchored with 1 (not at all positive/negative) and 4 (extremely positive/negative). Afterwards, the averages of all three items were included into the Griffin formula (Thompson et al., 1995): $(P+N)/2 - |P-N|$. The first part assesses the intensity of the components (i.e., the magnitude of the evaluation), while the latter part assesses their similarity in magnitude (Thompson et al., 1995). Thus, individuals with strong positive and negative attitudes have the highest ambivalence.

Additionally, we included a context-independent measure of FA as inner conflict in accordance to Priester and Petty (Priester and Petty, 1996). The participants were asked to indicate how conflicted,

indecisive and mixed they feel towards the use of AI on three 11-point scales, anchored with 0 (I feel no conflict at all/ I feel no indecision at all/ I have completely one-sided reactions) and 10 (I feel maximum conflict/ I feel maximum indecision/ I have completely mixed reactions). Afterwards, a FA score was calculated by averaging all three responses. As both measures are standardized measures of ambivalence, which can be found in literature, these items were measured on different scales. All items are listed in Table 2 in the appendix. Furthermore, we included age, gender and prior knowledge about AI as control variables.

Furthermore, to understand which context-specific attitudes towards using artificial intelligence as a decision aid cause PA (H1), we aim to conduct an exploratory analysis by a hierarchical regression model with a stepwise inclusion of physicians' context specific attitudes. Utilizing a stepwise inclusion, it can be assured that only items are included that explain a significant amount of additional variance. For doing so, we need contextualized measures which are able to capture specific attitudes towards AI in healthcare (see for similar approach Bick et al., 2015). Thus, based on a content analysis of qualitative data of an open question in prior study with over 180 medical students (Jussupow et al., 2018), we developed a list of 23 attitude statements which can be found in Table 5 (of the result section). As ambivalent attitudes result from individuals' evaluation of each attitude, we measured both the valence of the attitude (indicated as positive, negative or both on a bipolar scale) and the agreement with each statement measured on a 5-point Likert scale from strongly agree to strongly disagree. The agreement score was multiplied by the valence to form a measure for context-specific negative and positive attitudes. That means that only if individuals perceive the statement to be positive the agreement was considered for the score of positive attitudes. Then the sum of all valanced agreements was calculated to form both context-specific negative and positive attitudes.

3.3. Participants

To validate our research propositions, an online survey in German targeting advanced medical students and board-certified physicians was conducted. As ICDSS are not widely implemented there should not be relevant differences in terms of knowledge or usage of these systems between the two cohorts. For our study, the participants were given a vignette describing IBM Watson (Jussupow et al., 2018). Afterwards, control questions were posed asking how realistic the participants believe the case to be. From 89 participants, 15 were excluded because of missing data and not considering the scenario to be related to ICDSS. The sample of 74 participants (58% female) consisted of 54 students in advanced medical education (on average 9th semester) and 20 trained physicians from different specializations. In this sample, differences between medical professionals and students considering PA, FA, resistance to change, prior knowledge or negative context-specific attitudes were not significant. Nevertheless, medical students had higher positive context-specific attitudes than medical professionals ($T=-2.31$, $p<.05$).

3 Results

4.1. Findings from Hypothesis Testing

Table 3 (appendix) documents the descriptive statistics of the analysed constructs. The results of the regression are shown in Table 4. PA alone is predicting resistance to change ($\beta=0.22$, $p<0.05$). However, when including FA into the regression, the effect of PA is not significant ($\beta=0.06$, n.s.) and FA significantly influences resistance to change ($\beta=0.28$, $p<0.05$). This indicates that FA could mediate the effect of PA on resistance to change. These results support H3 as FA increases resistance to change. Furthermore, explains additional variance compared to considering only positive and negative attitudes alone (H5) (F-change=4.49, $p<0.05$). Furthermore, the effect of positive attitudes on resistance to change is not significant when including ambivalence ($\beta=-0.17$, n.s.). The Durbin-Wartson-Statistics is at 2.17 for the final model which is close to 2 indicating no dependencies of residuals. The tolerance values and the variance inflation factor do not indicate multi-collinearity of the constructs.

Moreover, we conducted a mediation analysis following the approach of (Hayes, 2013) with FA as mediator of the influence of PA on resistance to change. All control variables were included and bootstrapping with 10,000 was conducted to test for significance of the indirect effect. We find a significant effect of PA on FA (T=4.92, p<.001) (H2) and a total effect on resistance to change (T=2.30, p<.05) while the direct effect is not significant (T=0.54, n.s.). The normal theory test for indirect effect indicates that FA fully mediates the effect of PA (Z=1.96, p<.05) (H4).

Dependent variable: Resistance to change	Stage 1	Stage 2	Stage 3	Stage 4
Control variables				
Age	0.03 (0.23)	-0.06 (-0.60)	-0.01 (-0.06)	0.00 (-0.02)
Gender	-0.33** (-2.82)	-0.24* (-2.35)	-0.27** (-2.72)	-0.24* (-2.52)
Prior Knowledge	0.08 (0.70)	0.19 (1.84)	0.19 (1.88)	0.23* (2.36)
Negative Attitudes		0.35** (2.89)	0.39*** (3.32)	0.36** (3.10)
Positive Attitudes		-0.26** (-2.19)	-0.17 (-1.36)	-0.18 (-1.50)
Independent variables				
Potential Ambivalence			0.22* (2.12)	0.06 (0.54)
Felt Ambivalence				0.28* (2.44)
Adjusted R^2	0.08	0.33	0.37	0.41
ΔR^2		0.27	0.04	0.05
F (d.f.)	3.03* (3,70)	8.34*** (5,68)	8.05*** (6,67)	8.26*** (7,66)
F change		14.54*** (2,68)	4.49* (1,67)	5.95* (1,66)
*Note. t-statistics are shown in parentheses. *p <0.05; **p <0.01; ***p <0.001.*				

Table 4. Results of the regression analysis.

4.2. Exploratory analysis

In order to determine context-specific attitudes towards using AI as decision support exist and impact ambivalence (H1) we conducted an exploratory factor analysis of 23 items based on the agreement scores. Five factors could be identified with one strong factor with eigenvalue over 7, i.e. impact on medical profession. Thus, the items loadings on this factor were removed and a second-factor analysis was conducted. The remaining items were grouped into four factors. The results are displayed in table 5. Although both positive and negative evaluations for each attitude statement exist, changes of the medical profession are mainly perceived to be negative and changes of the efficiency of care positive. Considering the descriptive results in Table 5, it becomes obvious that physicians hold both strong positive and strong negative attitudes towards using artificial intelligence as decision aid (ICDSS).

Sum of participants rating of positive, negative or both / Context specific items: The introduction of ICDSS changes …		Average agreement (1 to 5)	Sum of positive evaluations	Sum of negative evaluations
Strongly negative attitudes				
Impact on medical profession	my reputation among my colleagues and/or other doctors.	3.62	28	67
	the reputation among my patients.	3.62	27	63
	the level of everyday professional initiative.	3.27	20	65
	the level of intellectual challenges associated with the profession.	2.92	28	59
	the way patients are treated.	2.88	31	63
	the attractiveness of the profession.	2.76	31	60
	the level of prestige associated with the profession.	2.76	26	66
	the relevance of medical professional experience.	2.70	27	62
Mixed attitudes				
Medical tasks	the level of my decision-making confidence.	4.16	58	35
	the way I make medical decisions.	4.03	53	45
	how much I rely on my own decisions.	3.95	38	56
	the level of personalized medical care.	3.92	47	43
	the total costs of the hospital.	3.58	52	48
Medical knowledge	the way I acquire new professional knowledge.	3.91	56	39
	the amount of knowledge I need to know by heart.	3.20	41	47
	the relevance to educate further.	2.89	25	56
Medical work	the relevance of data security, liability and legal issues.	4.04	34	57
	the way I work.	3.66	57	44
Strongly positive attitudes				
Efficiency of care	the degree of standardization in medical decision-making.	3.81	62	22
	the amount of time I need for decision making	3.58	68	28
	number of medical errors.	3.53	65	29
	my workload.	3.28	59	37
	replaces some of the tasks usually performed by doctors.	3.08	40	58

Table 5. Context-specific evaluations towards using AI as decision support.

In order to understand which specific attitudes contribute to PA, we conducted a hierarchical regression analysis. An adjusted R^2 of 35% of the variance of PA was explained through context-specific attitudes after six steps (see Table 6). Specifically, individuals who that ICDSS negatively influences how patients are treated and see the benefits for professional initiative experience stronger ambivalence. Furthermore, attitudes with negative effect on PA are strong predictors if individuals have high negative or positive univalent attitudes.

Dependent variable: Potential ambivalence	*Model 9*	
Independent variables		
Negative evaluation of how ICDSS influences medical errors	-0.47***	(5.17)
Positive evaluation of the change on the way of work.	-0.40***	(-3.83)
Negative evaluation of the impact on standardization of care	-0.30***	(-3.54)
Negative evaluation of changes in the amount of medical knowledge	-0.38***	(-4.17)
Negative evaluation of influence on intellectual challenge	-0.42***	(-3.68)
Positive evaluation of changes the way of medical decisions	-0.29**	(-3.08)
Positive evaluation of how ICDSS influence medical errors	-0.17ns	(-1.75)
Negative evaluation of how ICDSS changes the way patients are treated	0.23*	(2.54)
Positive impact on the level of everyday professional initiative	0.32**	(2.84)
Positive evaluation of that ICDSS replaces some of the tasks usually performed by doctors	-0.21*	(-2.09)
Adjusted R2	0.52	
F (d.f.)	9.60***	(9, 64)
*Note. t-statistics are shown in parentheses. *p <0.05; **p <0.01; ***p <0.001.*		

Table 6. Results of step-wise regression analysis with potential ambivalence as dependent variable.

4 Discussion

Based on our study, we have been able to demonstrate that ambivalence is an important construct to consider in information systems research. Context-specific attitudes towards using artificial intelligence as decision support in healthcare cause PA (H1) which has a direct effect on FA (H2). Yet, the effect of PA on resistance to change is mediated by FA (H3, H4). Moreover, ambivalent attitudes still cause a preference to the status quo when controlled for influence of context-specific univalent attitudes (H5). Hence, our findings address the increasing critique on uni-dimensional conceptualization of constructs and underpin the theoretical and practical relevance of our research (Piderit, 2000). Furthermore, we have been able to identify context-specific attitudes which foster the development of ambivalence towards AI. Thus, our findings help to understand how ambivalence is formed as individuals with higher degree of ambivalence are more likely to change their opinion.

4.1 Major contributions

By measuring the impact of ambivalence towards AI in healthcare, we contribute to contextualized research in information systems (Burton-Jones and Grange, 2013; Hong et al., 2014) and to the understanding of ambivalence in the context of technology implementation (Moody et al., 2017). Our results indicate that ambivalent attitudes towards using AI as decision aid are a matter of cognition and of emotion as FA mediates the effects of PA. Specific attitudes towards the technological change influences whether ambivalence is formed. Furthermore, by applying a standardized measure of ambivalence into the context of information systems (Hong et al., 2014), we are able to quantify the impact of ambivalence. Moreover, our study contributes to the understanding of the consequences of ambivalence. In current research, the relationship between ambivalence and resistance to change was proposed in the literature (Rothman et al., 2017), but not yet empirically tested.

Our findings also have implications for practice, especially when introducing controversial information technology (Breward et al., 2017) or in contexts of mandated technology implementation (Laumer et al., 2016), which is often the case in healthcare. In these contexts, the introduced technology is object to strong controversy and individuals build both negative and positive attitudes. But some

individuals may develop a subjective feeling of discomfort (FA). Furthermore, although in a nascent state for clinical practice, artificial intelligence is already a topic of strong controversy among physicians in healthcare. Thus, technology companies who intend to implement AI should not solely focus on physicians with strong positive or strong negative attitudes, but consider how to address ambivalence of professionals.

4.2 Limitations and future research

As shown in this study, the subjective feeling of ambivalence is a more comprehensive predictor of resistance to change. Therefore, further research should address how the feeling of ambivalence arises in different technological and organizational settings and how management can encounter these. Further research should link ambivalence with other factors from technology adoption literature, such as intention to use and other constructs from the TAM model (Venkatesh et al., 2003) and also include other predictors of resistance to change (Kim and Kankanhalli, 2017). Moreover, this study only examined ambivalence in one specific context. Further research should consider other system types as well as other business domains to evaluate if there are generalizable characteristics of technology and implementation context (e.g. mandatory usage, power relationships), which influence the degree of ambivalence experienced by users. Furthermore, our study cohort included both novice and experienced physicians as we were interested in the measurement of ambivalence. To assess the impact in the context of different technological implementations, future research should examine ambivalence of more senior professionals and other decision-makers in the healthcare domain. Moreover, future research should examine distinct effects of specific forms of PA (cognitive, affective or cognitive-affective). Furthermore, future research should consider which technology-specific factors cause ambivalence and aim to generalize the findings of this study into a more comprehensive model.

4.3 Conclusion

To sum up, our study examined the consequences of physicians being torn between positive and negative aspects of ICDSS. The experienced psychological discomfort from this ambivalent state results in preference for the status quo and inhibits implementation of ICDSS. With our study we were able to quantitatively measure ambivalence and to distinguish different states of ambivalence. This study has yielded promising insights and addresses multiple gaps in general IS literature by affirming existing calls for contextualized IS research (Alvesson and Kärreman, 2007; Burton-Jones and Volkoff, 2017; Hong et al., 2014) as well as reconceptualizing prevailing uni-dimensional measures of attitudes (Jensen and Aanestad, 2007; Moody et al., 2017; Turel, 2015; Van Offenbeek et al., 2013). Our findings have furthermore increased our understanding of the impact of ambivalence towards the resistance to change (Rothman et al., 2017) as well as the influence of attitudes towards an emerging disruptive technology like artificial intelligence. The obtained findings illustrate the relevance for further research on ambivalence, its antecedents and effects as well as on integrating the concept of ambivalence into the cumulative tradition of IS research.

5 Appendix

Construct	Items	
Potential Ambivalence (PA) (Thompson et al., 1995)	CP	Consider only the advantageous qualities of ICDSS and ignore the disadvantageous ones. How advantageous are they?
	AP	Consider only the pleasant feelings towards ICDSS and ignore the unpleasant ones. How pleasant are these?
	OAP	Consider only the positive aspects about ICDSS and ignore the negative ones. How positive are they?
	CN	Consider only the disadvantageous qualities of ICDSS and ignore the advantageous ones. How detrimental are they?
	AN	Consider only the unpleasant feelings and ignore the pleasant ones. How unpleasant are they?
	OAN	Consider only the negative aspects about ICDSS and ignore the positive ones. How negative are they?
Felt Ambivalence (FA) (Priester and Petty, 1996)	FA1	How torn do you feel?
	FA2	How indecisive do you feel?
	FA3	How mixed are your feelings?
Resistance to Change (RC) (Bhattacherjee and Hikmet, 2007)	RC1	I don't want ICDSS to change the way I order patient tests.
	RC2	I don't want ICDSS to change the way I make clinical decisions.
	RC3	I don't want ICDSS to change the way I interact with other people on my job.
	RC4	Overall, I don't want ICDSS to change the way I currently work.
Prior knowledge	PK1	I've never heard anything about AI – I've heard a lot about AI
	PK2	I've never dealt with AI before – I've dealt with AI before before
	PK3	I do not want to know more about AI– I do want to know more about AI

Table 2. List of used items in the study.

	Mean (S.D)	1	2	3	4	5	6	7	8
Resistance to change	3.52 (0.87)	1							
Age	27.54 (7.11)	0.12	1						
Gender	1.23 (0.61)	-0.33**	-0.21	1					
Prior knowledge	3.18 (0.89)	-0.05	0.26*	0.13	1				
Negative Attitudes	30.08 (19.77)	0.51**	0.14	-0.22	-0.15	1			
Positive Attitudes	29.16 (21.12)	-0.47**	-0.13	0.19	0.16-	-0.59**	1		
PA	1.91 (0.91)	0.18	-0.26*	-0.08	-0.04	-0.09	-0.23	1	
FA	6.73 (2.82)	0.35**	-0.17	-0.04	-0.23*	0.13	-0.21	0.51**	1
*Note. *p <0.05; **p <0.01; ***p <0.001.*									

Table 3. Descriptives

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