Conceptualizing User Choice as Motivational Factor in Ad-Hoc Tumor Board Scheduling Applications

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Abstract. We address the theory-driven design of ad-hoc tumor board scheduling applications for improving cancer therapy by developing and testing a theoretical model of the relationship between user choice, autonomy gain, and voluntary use. Physicians' motivation and voluntary use are crucial for the success of these applications. Current theory holds that user choice is instrumental in fostering perceived autonomy and creates intrinsic motivation to use systems. We argue that this effect has boundaries particularly relevant to the hospital context: Under high social and cognitive demands, frequently found in cancer therapy, user choice and resulting autonomy have less motivational effects. Results of a sequential mixed methods study with students and experienced physicians support our research model. This study adds to theory on the motivational effects of user choice by identifying an important boundary condition of extant theory, namely social cognitive constraints, and provides direct design implications for ad-hoc tumor boards scheduling applications.

Keywords: Tumor boards, Self-Determination Theory, User choice, Autonomy, Voluntary use

1 Introduction

Tumor boards constitute an essential element in the diagnosis and treatment process for patients with cancer, a group of diseases that currently accounts for more than 600,000 yearly deaths in the US alone [1] while the number of new cases is expected to grow dramatically [2]. Tumor boards are multi-disciplinary meetings of specialists from different medical fields that holistically discuss single cancer patients' medical situation and decide about recommended treatment plans for each patient [3]. Due to their importance for life-threatened cancer patients, tumor boards are subject to heavy scrutiny by regulators and ethical review committees. For example, they may only give treatment recommendations if medical specialists of sufficient rank from all relevant disciplines are present during a tumor board meeting and declare their consent with the recommendations [3-4]. To ensure that all necessary roles are present and to balance the workload of their specialists, hospitals currently schedule tumor boards well in advance, often one week or more [3]. From a patient's perspective, however, this lead time results in delayed treatment, causes increased stress and anxiety, and carries the risk of the disease progressing further during the delay [5-7]. One way to address these

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issues lies in the arrangement of ad-hoc tumor boards during physicians' daily routine. They enable hospitals to conduct tumor boards more frequently, and patients benefit from the time savings. This requires, however, information systems (IS) that support the arrangement of ad-hoc tumor boards. Otherwise, taking care of the large quantity of heterogeneous information regarding the patient cases and physicians' availabilities would counteract the desired time savings.

From a job perspective, this entails significant changes for physicians who participate in tumor boards: Whereas traditional tumor board arrangements achieve coordination of multiple specialists' heavily loaded schedules by planning well in advance, ad-hoc tumor board arrangements require communication and fast mutual adaptation from the specialists to come to possible appointments. Through this profound change, various challenges arise. First, physicians may perceive such mutual adaptation as cumbersome effort given a full schedule. Secondly, the comparatively high speed of arrangements of ad-hoc tumor boards completely relies on the voluntary participation of physicians as the hospitals' possibilities to control and enforce participation in the arrangement process are very limited. If not countered, such information asymmetry and effort perceptions can trigger physicians' resistance against new IS [8]. Therefore, successful implementations of ad-hoc tumor boards need to aim to motivate physicians to voluntarily participate in the arrangement process. More precisely, physicians have to be motivated intrinsically for a voluntariness-based scheduling process to remain sustainable. Prior work has shown that voluntary action and intrinsic motivation can generally be fostered through providing choice possibilities and thereby enhancing individuals' feeling of autonomy [9-10]. However, recently scholars have called into question whether more choice has generally a motivating effect. In particular, users may possibly suffer from too much choice as it strains their cognitive resources [11-12] and not everybody responds positively to offered choices [13-14]. This is particularly relevant for physicians as their working context is often both physically and mentally exhaustive [15], and previous work has even suggested to reduce user choice in supporting IS for healthcare to a minimum [12]. Since it is important to foster physicians' motivation to voluntarily participate in scheduling ad-hoc tumor boards by using appropriate IS, it appears crucial to better understand such effects. We consequently aim to answer the following research questions:

1. *Why and how does user choice provided to physicians lead to increased motivation for voluntary use in a hospital context?*
2. *How can ad-hoc tumor board scheduling applications be designed to leverage user choice as an intrinsic motivating factor for using the applications?*

While we are engaged in a larger design science project to develop a full ad-hoc tumor board solution, we approach these two important research questions primarily from a theory-driven empirical perspective. Nonetheless, it is one major goal to develop clear and context-specific design implications for ad-hoc tumor boards. In this research we therefore aim to (1) develop a research model that provides a more differentiated understanding of the contingencies influencing the motivational effects of user choice and their boundaries; and (2) contextualize and test the model in the domain of voluntary use of IS for scheduling ad-hoc tumor boards. By answering these research

questions, we add to current theory on the motivational effects of user choice [10] and provide guidelines for developing ad-hoc tumor board systems that stimulate physicians' voluntary use with a personalized level of user choice that is adapted to the level of social cognitive constraints (SCC). Ultimately, this will hopefully contribute to quicker tumor board decisions and thereby faster therapy for cancer patients.

2 Theoretical background

Tumor boards: Tumor boards constitute an essential part of the diagnosis and treatment plan of cancer patients. Physicians, specialized in different medical disciplines, review and discusses the further treatment and diagnosis steps of a cancer patient. There are different types of tumor boards for different tumor entities that involve physicians from different, pre-defined medical disciplines. For this reason, and depending on other factors like hospital size and availability of physicians, the meeting frequency of individual tumor board types often varies from once a week to once a month in developed countries [3]. A group of physicians in a tumor board is only entitled to make medical decisions if physicians of predefined medical disciplines are involved in the decision making process and agree with the final decision [3-4]. On the one hand, this increases the decision quality as physicians participate only in tumor boards where they hold specialized expertise. On the other hand, it also increases the complexity of coordinating the schedules of different specialists which results in longer planning periods and delays in patient treatment. Especially for cancer patients, however, this is valuable time connected with more individual stress, anxiety and the risk for the tumor to metastasize [5-7]. Reducing the planning time before tumor board has, therefore, essential impact on the patient's treatment success.

There are only limited technical solutions to accelerate the tumor board planning process. Solutions such as daily tumor boards for all tumor entities or general tumor boards with no specialization are not feasible. These solutions come with high risks to waste the physicians valuable time (e.g. if physicians reserve time for a meeting and there are no cases available) and are not realizable as there are more than a dozen different tumor boards for different tumor entities. Due to US and EU regulations, the involvement of different, specific medical disciplines is mandatory for any treatment recommendation [16-17]. Hence, the only option we currently see to accelerate tumor board planning and execution are ad-hoc tumor boards. In contrast to traditional tumor boards, ad-hoc tumor boards are planned immediately when a request arrives and held within a few minutes or hours in contrast to several days. As participants are not determined beforehand, the available physicians have to volunteer and quickly form a competent group. However, planning ad-hoc tumor boards bears a lot of complexity due to the large amount of participants, their different specializations and schedules, the regulatory tumor board constraints and the hospital environment itself, which is often hectic and unpredictable, putting high cognitive and emotional demand on physicians [15]. This results in less motivation to voluntarily engage in additional activities such as ad-hoc tumor boards. Besides, particularly physicians are known for their heavy resistance to technologies and process changes that distract them from their

primary tasks or impair their autonomy [18-19]. From a requirements perspective, it is therefore essential to build an application which fosters the motivation to volunteer in a tumor board and at the same time fits into the clinical environment.

User choice and Self-Determination Theory: A particularly prominent way to motivate users to engage in voluntary action is satisfying their need for autonomy by giving them choice in what they do [10], [13]. According to the Self-Determination Theory (SDT) [10], autonomy is defined as the need of having the perception of control over the situation and having the possibility to decide and influence the outcome according to one's preferences [20-21]. Literature indicates, that autonomy can be accomplished by an IS design, which provides the user with flexibility and options of choice [10], [22].

Particularly autonomy and user choice are closely related: Having options of choice increases intrinsic motivation and benefits performance [23] and being deprived of options decreases motivation and can even result in reactance [14], [24]. However, the positive effects of choice are limited [25] and research indicates that there may also be negative effects of user choice: It can lead to information overload [26-27], feelings of constraint and effort [11], [28] as well as individual stress and performance decrease [26]. Concluding, too much choice can overwhelm the user. Moeller et al. [9] try to integrate the positive and negative motivational effects of choice by arguing that only choice which is perceived as autonomous is motivating. The authors define autonomous choice as a choice with an internal locus of causality, meaning that individuals have the perception of actively influencing the outcome of the choice [9]. However, this explanation has two major limitations: first, it does not explain why there are situations, e.g. in healthcare, in which less choice can be more motivating than more choice [12] and second, it is too unspecific to be translated into design implications.

3 Theoretical model

In order to improve our understanding of when user choice benefits intrinsic motivation and voluntary actions and to provide theoretical insights with direct design implications, we developed a context-specific theoretical model for the voluntary use of ad-hoc tumor boards by physicians. Following the reasoning of SDT, we argue that more user choice provided by applications, is generally perceived as a gain in autonomy and increases the intrinsic motivation to use these applications [13]. We theorize that individual autonomy gain does, however, not always lead to voluntary use, since individuals need to have social influence on the outcome and enough resources to process the options of choice. Hence, we argue that SCC negatively moderate this relationship.

To contextualize this high level theory [29] to the specific domain of physicians' voluntary use of tumor board software, we apply this theoretical reasoning to the design of user interfaces for making appointments for ad-hoc tumor boards. In more detail, user choice is contextualized to display options for meeting timeslots. The theoretical model is depicted in Figure 1 and developed subsequently.

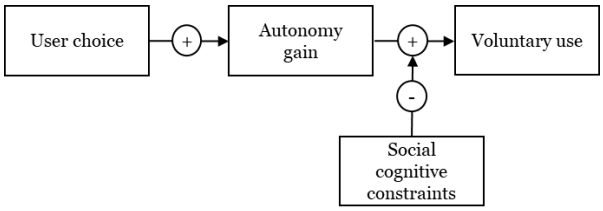

Figure 1. Research Model

User choice: Following SDT, we argue that more user choice leads to more perceived autonomy [10]. Our model is based upon the assumption, that the provided choice has both high relevance and a positive subjective value add so that it can lead to autonomy gain and volunteering [13]. We operationalize user choice with number of options and agency, both design elements for the user interface.

First, user choice has to contain more than one option of choice. Literature indicates that if individuals are deprived of options, they experience reactance [24] and in extreme, even a feeling of helplessness [30]. Besides, a meta-analysis shows that comparing options of choice against no options of choice has the largest effect on intrinsic motivation [23]. In general, more options provide a higher chance that at least one option meets the user preferences increasing the user's perceived autonomy.

Second, individuals can be allowed to exert agency to differing degrees where high degrees of agency lead them to firmly believe they are making a choice themselves, meaning that they are the agent of the choice [11], [31]. For example, receiving a list of possible appointment times to choose from provides less chances to exert agency than being asked to proactively suggest a list of possible time slots for others to choose from. Individuals arguably perceive a choice as increasing their own autonomy more if they are provided with more chances to exert agency. If, on the other hand, a choice is forced on them by someone else individuals would not experience any feeling of autonomy [9]. We therefore theorize:

H1: More user choice, i.e. more available options and more possibilities to exert agency, leads to more perceived autonomy

Perceived Autonomy: Following the reasoning of the SDT, we argue that if user choice leads to an autonomy gain, it increases the user's intrinsic motivation, which leads to more voluntary usage [10], [31]. Especially for physicians, autonomy is an important driver for action [19]. Hence, information systems research identified perceived threat to physicians' autonomy as one important source of their resistance against new technology [19], [33]. So, we argue:

H2: The more users perceive an autonomy gain the higher their propensity to voluntarily use the application

Social cognitive constraints: However, in a hospital context, physicians have only limited resources they can spend on different choices. Relevant to this context, we argue that the perceived autonomy of individuals does not always lead to more motivation

but that this relationship depends on the context individuals are facing. In a high SCC context, individuals may prefer less choice and less autonomy, while in a low SCC context, individuals may prefer more choice and more autonomy. We define SCC as the degree to which the social context and cognitive situational demands constrain the individual's scope of action, by limiting individuals influence on the outcome and reduce their available resources. Individuals' perceived influence on the outcome can be defined as the degree to which individuals perceive to have an effect on the outcome through their own actions (also known as locus of causality [9]). It is thereby different from the objective possibility to exert agency and influenced by a number of factors. For instance, in strong hierarchical work settings, such as in hospitals, low-ranking individuals have less influence on the meeting schedule than in settings with less hierarchy. That is, even though they may have a user interface in which they can propose time slots, they may know that their superior's availability fully overrules their preferences. Being provided with more possibilities to exert agency or more options to choose from does consequently not make any difference for them because they feel that they do not have control over the outcome. Literature further indicates that under high time pressure [34] and cognitive load [26], conditions which are often present in hospitals [15], individuals have less perceived control over choice outcomes. Additionally, individuals have only limited available cognitive and emotional resources which they can allocate for the task. We define resources as cognitive capacity to process information [26-27] and the capacity to volunteer [35]. More autonomy in choosing requires more of the individuals' resources to evaluate the possibilities, such as more time and more cognitive capacity. Too many options of choice can result in choice overload [36]. Besides, under high time pressure individuals have to choose fast without much consideration and are often relying on automatic processes such as habits and heuristics [37]. Especially in the hospital context, physicians have to make fast decisions and have only limited spare resources for the ad-hoc tumor board scheduling application. Accounting for the perceived outcome of choice and the available resources we therefore theorize:

H3: Social cognitive constraints have a negative effect on the relationship between autonomy and voluntary use

4 Research Design

Development of user interfaces: For our research design, we systematically developed a set of six user interfaces. For tumor board meetings user choice is limited to the questions of if and when to attend the tumor board meeting since the scheduling algorithm will determine the participants, patient case and place. So, we systematically developed six user interfaces varying the number of options of choice and the degree of agency creating low and high user choice designs (see Table 1 and Figure 2).

Table 1. Interface Design (Designs, see also Figure 2)

	Low degree of user choice	*High degree of user choice*
Options of choice	One timeslot and limited answer options (Designs 1 to 3)	Multiple timeslots and answer options such as prioritize alternatives (Designs 4 to 6)
Agency	Users receive timeslot suggestions (Designs 1 to 4)	Users can propose timeslots by themselves (Designs 5 and 6)

Research context: Our research takes place in a full care public hospital in Germany with more than 1,300 beds. The research is embedded into a multidisciplinary project that aims to develop innovative technologies and methods for cancer treatment. In this hospital, more than 10 different tumor boards take place on a weekly basis.
Furthermore, physicians' day to day work is highly demand driven and varies in time pressure as well as in number of parallel decisions, all reducing physicians' available resources [15]. This unique context offers the opportunity to compare variances in SCC, based on hierarchy levels and resource capacity. Hence, we used this context for the mixed methods evaluation of our proposed theoretical model and to derive design implications.

Research design: We use a mixed-method design of sequential quantitative and qualitative investigations [38] to test our theoretical model and to systematically derive design implications for the tumor board scheduling application.
First, we evaluated the developed user interfaces with a quantitative measure, an online survey, with a group of students (n=44, age M=24.6, SD=4.4; 45% female). Students are usually flexible in their daily schedule and have therefore low levels of SCC. This makes them a suitable SCC neutral group to evaluate our user interfaces. For the analysis, we excluded 5 participants due to not complying with a filter question. The students were introduced to the setting of the tumor board application with an introduction text. Then all students rated the user interfaces on the variables autonomy and effort expectancy on a 5-point Likert like scale ranging from 1 being "Strongly Disagree" to 5 "Strongly Agree". The items are displayed in Table 2. Afterwards, the students had to rank the designs according to their intention to use it for scheduling an ad-hoc tumor board.

Second, we gathered qualitative data from 11 radiologists (age M=33.9, SD=4.4; 55% female) who are participating in tumor boards on a regular basis. We showed the physicians four interfaces (Designs 2, 3, 4 and 6) and had them choose the interface they would use and one they would definitely not use. Furthermore, we asked the physicians to provide qualitative information about why they have made this choice. Besides, we evaluated the SCC on a 7-point Likert scale (see items in Table 2) and conducted in-depth interviews with multiple physicians from different hierarchy levels.

Table 2. Items

Autonomy [39]	I would have more control over my meetings while using this app This app gives me more chances to control my meetings This app provides me more opportunities to manage myself
Effort expectancy [40]	The interface is easy to learn The interface is simple I can put data quickly using the interface
Social cognitive constraints adapted from [41]	I can choose the time for tumor boards I can choose if I want to participate in a tumor board Overall I have low control over my daily schedule Fixed schedules are structuring my day
Voluntary use	Please rank the user interfaces according to your preferences (student study) Please select the user interface you would prefer to use for scheduling tumor board meetings (physicians)

5 Results

User choice leads to more autonomy. In the quantitative study, all students evaluated the user interfaces with different user choice levels according to autonomy and effort expectancy. The differences (t-tests) between the user interfaces were all highly significant (Means see Figure 2, $p<.001$). Hence, we confirmed hypothesis 1 that designs with more user choice lead to higher perceived autonomy.

Autonomy leads to more voluntary use. Students have high scheduling flexibility and no constraints, thus a low SCC context. In the survey we asked the students to choose the user interface which they would use for scheduling ad-hoc tumor boards. Designs with high user choice, designs 4, 5 and 6, were preferred by 70% of the students supporting hypothesis 2 that higher autonomy leads to more voluntary usage. However, design 4 alone was preferred by most students (36%). Hence, autonomy gain appears to be only beneficial for voluntary usage if it does not impair usability (See Figure 2).

Effect of low or high SCC in the hospital context: In our second study, we expanded our proposed model by taking into account the specific hospital context with different levels of SCC for physicians. All radiologists (n=11) strongly agreed (M=5.8, SD=1.2) on a 7-point Likert-scale that tumor boards are highly important.

We asked about the design preference of the physicians to assess the relationship between autonomy and voluntary usage. The majority of physicians (54%) indicated that they would use the low user choice designs (2 and 3) for the tumor board scheduling application and design 3 alone was preferred by 45%. These designs provided the physicians with the "best balance between choice and simplicity" (Interview data).

Design 6, the one with the highest user choice, was only preferred by the outstandingly high-ranking physician. For all other physicians this design was “too complex” and two third indicated that they would definitively not use this interface. The high-ranking physician later explained, that he preferred this user interface since it allows him to fit ad-hoc tumor boards with his schedule. He indicated having a lot of control over his daily schedule and being able to choose the timeslots for the tumor boards by himself. Hence, the high-ranking physician faced low SCC and had similar preferences as the student sample.

All other physicians faced high SCC. On a 7-point Likert scale from 1 being “strongly disagree” and 7 being “strongly agree”, the other physicians indicated not being able to choose the timeslot for tumor board meetings (M=6.9, SD=0.3), not being able to decide if to participate in tumor board meetings (M=5.9, SD=1.9), generally having low control over their schedule (M=5.0, SD=1.3) and having the feeling that tumor boards help to structure their day (M=4.5, SD=1.3). One physician, who preferred design 3, explained that design 6 would not work in his daily routine since he could not plan his schedule freely and that he received a lot of urgent last minute requests. After he would have indicated a time span there could always be an important surgery spontaneously scheduled exactly in this time span. For him, fixed time slots for the tumor board helped him to structure his day, decreased his effort for organizing meetings and increased predictability and autonomy. Especially during high stress situations, he indicated, he would prefer a simpler design. This confirms hypothesis 3 that high SCC negatively affect the relationship between autonomy and voluntary use.

Overall, the results show that SCC influences the relationship between autonomy and voluntary use. When physicians have low influence on the outcome and restricted resources they prefer to use a simpler design with less user choice and less autonomy.

Average	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Autonomy	2.83 (0.97)	2.27 (0.97)	2.75 (0.71)	4.03 (0.70)	4.05 (0.71)	4.07 (0.63)
Effort expectancy	4.27 (0.91)	4.73 (0.41)	4.68 (0.50)	4.35 (0.68)	3.95 (0.80)	3.84 (0.91)

Figure 2. Mean values and standard derivations of developed user interfaces (designs)

6 Discussion and Contributions

This study contributes to literature on the motivational effects of user choice in general [13], [23] and on the role of user choice in motivating highly skilled healthcare personnel in particular [8], [12]. While user choice is a known stimulant for perceived

autonomy and intrinsic motivation [23], prior research has suggested that this effect may not infinitely increase with growing user choice [8], [13], [36]. Although physicians are known to resist new processes and IS particularly when they feel constrained by them [18], little research has investigated why and how IS may be designed to increase physicians' autonomy perceptions and motivation [8]. We close a gap in literature about how users' context influences voluntary use [42-43] by developing and testing a research model based on SDT that provides a more differentiated understanding of the contingencies and boundaries of the motivational effects of user choice.

From a theoretical perspective, our results show that more options of choice and agency are associated with autonomy gains that lead to a higher degree of voluntary use only when users are not constrained in their resources or social structures. This suggests that those who recommend to keep user choice in IT healthcare preferably at low levels [12] should take SCC more into account. More user choice may actually be preferable in little constrained hospital contexts in order to keep, for example, physicians from resisting technology adoption and systems change [8]. Contrastingly, in highly constrained situations, a reduction of user choice may indeed be necessary.

From a practical perspective, this has clear design implications. As such, IS that aim to motivate voluntary use in different contexts should rely on personalized and context-aware adaptations to the SCC of the user. We aim to incorporate our findings into the design of an application that motivates physicians to voluntarily use it for arranging and conducting ad-hoc tumor boards. Two user interfaces are planned that allow for adapting the amount of user choice to situations of physicians with either high or low SCC. This is expected to aid in effectively scheduling ad-hoc tumor boards and making their success possible. A consequent reduction of the delay before cancer patients receive their treatment plan may well save many lives in the future.

We show initial positive results of the proposed research model in a mixed methods study with students and expert physicians that often attend tumor boards. However, our work has limitations that need to be acknowledged. In future work, the empirical basis of this model has to be extended by first, increasing the sample size and secondly by including physicians from further medical specialties such as oncology and surgery. To understand how variations in SCC influence the relationship between autonomy and voluntary use, a field experiment would be interesting. There, options of choice and agency can be systematically varied in the user interface. Furthermore, voluntary use can be assessed by real usage behavior. In the presented study we could not fully rule out individual level biases that can affect physicians' system use such as their value systems or their integration with their hospital [44]. In the future field experiment, we will be able to control for such potentially biasing factors.

7 References

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