Counteracting Anchoring Effects in Group Decision Making

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Abstract. Similar to single user decisions, group decisions can be affected by decision biases. In this paper we analyze anchoring effects as a specific type of decision bias in the context of group decision scenarios. On the basis of the results of a user study in the domain of software requirements prioritization we discuss results regarding the optimal time when preference information of other users should be disclosed to the current user. Furthermore, we show that explanations can increase the satisfaction of group members with various aspects of a group decision process (e.g., satisfaction with the decision and decision support quality).

Keywords: Group decision making · Recommender systems · Decision biases · Anchoring effects

1 Introduction

Many decisions in everyday life occur in the context of groups, for example, a decision regarding the restaurant to choose for a dinner with friends or a decision regarding the next years' conference or workshop location. A major objective of the CHOICLA[1] group decision support environment is to support different types of group decision scenarios in an efficient fashion. CHOICLA includes functionalities that determine recommendations on the basis of individual preferences of group members. When dealing with group decisions, one has to cope with different types of *decision biases* which can deteriorate decision quality. We will first provide a short overview of such biases and then focus on the aspect of how to counteract anchoring effects in group decision making. For a more detailed overview of such biases we refer to [4].

Serial position effects occur in situations where items at the beginning and the end of a list are evaluated more often (behavioural aspect) and also recalled (cognitive aspect) more often [5,15] than items in the middle of a list.

[1] www.choicla.com.

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Such items can be argumentations in product descriptions [18], products and their attributes [5], and lists of links [15]. Such effects can occur independent of the popularity of an attribute or item, for example, item properties presented at the beginning and the end of a recommendation dialog are recalled more often independent of their popularity [5]. A possibility to counteract serial position effects in group-based recommendation is to change the preference acquisition interface, for example, from a star-based rating to a utility-based rating (items are evaluated with regard to a predefined set of interest dimensions) which encourages users to analyse item descriptions in more detail [18].

Decoy effects cause shifts in preference construction since decisions are taken depending on the context in which alternatives are presented to the user [22]. For example, including a completely inferior alternative (e.g., with the lowest overall utility compared to all other alternatives in a list of recommended items) can change a user's evaluation of the remaining items in the list. In the context of recommenders, such effects have been analyzed by Teppan et al. [20] who showed the existence of decoy effects on the basis of real-world financial services datasets. Counteracting decoy effects can be based on predictive models that predict decoy items which could be eliminated from a result set [20].

Explanations can have a significant impact on the way that items are perceived/evaluated and – as a consequence – on the corresponding decision. Thus, explanations play an important role in recommender systems [8,21], for example, a digital camera will be purchased or not, a movie will be watched or not, a car feature will we included or not, a project proposal will be accepted or not, and a software requirement will be regarded as important or not. Stettinger et al. [18] analyze the impact of argument orderings of item explanations on the decision outcome, Felfernig et al. [6] and Pu et al. [16] show the (positive) influence of explanations on a user's trust in recommender systems, and Herlocker et al. [10] discuss different explanation-relevant dimensions in recommender systems where beside *justification*, *user involvement*, and *education*, *acceptance* is mentioned as a major relevant factor.

Anchoring effects cause decisions which are influenced by the group member who first articulated his/her preferences [1,11] – these results in the context of decision support environments are confirmed by social-psychological studies that point out the relationship between decision quality and the visibility of individual preferences for other group members [9,14]. Interestingly, hidden preferences in early phases of group decision scenarios can increase the overall amount of information exchange between group members and the higher the amount of information exchange the higher the quality of the decision outcome. In collaborative filtering scenarios, anchoring effects can be triggered by disclosing, for example, the average rating of other (similar) users. An adaptation of the preference acquisition interface (e.g., a rating scale adapted from a 5-star to a binary one) can help to counteract such biases in collaborative filtering [1,2].

The existence of anchoring effects in group decision scenarios has also been shown in Felfernig et al. [7] who analyzed bias-induced preference shifts in the context of requirements engineering. In this scenario, the task of the project team

was to make decisions regarding different technical and organizational aspects of their software project. Examples of such decisions are the way in which their software project should be evaluated and the type of technology that should be used for implementing the requirements. Masthoff and Gatt [13] discuss algorithmic approaches to satisfaction prediction in group decision scenarios where *conformity* (judgments are influenced by the judgements already articulated by other group members) and *emotional contagion* (influence of an individual's affective state on that of other group members) are mentioned as influence factors. Compared to Masthoff and Gatt [13], we did not analyze emotional states of group members and focused on the impacts of different degrees of judgement visibility. An analysis of intra-group dynamics in CHOICLA decision scenarios is within the scope of future work. Our major focus in this paper is to show in which way anchoring effects can be counteracted in the context of group decision making. In this context, we focus on a *requirements prioritization scenario* where groups of students (teams) had to agree on the set of additional requirements (and their priority) they are willing to implement in their software project. In addition, we investigated the impact of explanations in group decision scenarios (explanations textually entered after a final decision has been taken). In this context we were interested on the impact that explanations can have on the overall acceptance of a group decision by individual group members.

As a basis for completing the requirements prioritization task the teams of our study used the CHOICLA group decision support environment. Example CHOICLA scenarios for industrial settings are the selection of new employees, the selection of conference locations, and the evaluation of project proposals. In the private context, CHOICLA can, for example, support the selection of a restaurant for a dinner with friends, the selection of a hotel for a holiday trip, and the selection of a cinema movie to watch with friends. In addition to CHOICLA, there exist many other group decision support environments. DOODLE[2] focuses primarily on the aspect of coordinating meetings and does not include additional mechanisms to determine recommendations for groups of users. Similarly, VERN [23] is a tool that supports the identification of meeting times based on the idea of unconstrained democracy where individuals are enabled to freely propose alternative dates themselves. SMARTOCRACY provides support for voting scenarios in social network contexts where information from the social network is applied to rank recommendations [17]. DOTMOCRACY[3] deals with larger groups of users and provides a method for collecting and visualizing group preferences. The system is based on the idea of participatory decision making – it's major outcome is a graph type visualization of the group-immanent preferences. Compared to CHOICLA, these tools focus on specific domains and do not offer the possibility for a flexible definition of domain-independent decision scenarios.

The contributions of this paper are the following: (1) we provide a short overview of the CHOICLA group decision support environment on the basis of a working example from the area of software requirements prioritization, (2) we

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show (a) the existence of anchoring effects and (b) possibilities of counteracting these effects in the context of group decision making, and (3) we show that explanations in group decision scenarios can have a positive impact on the overall acceptance of group decisions. The remainder of this paper is organized as follows. In Section 2 we provide an overview of the CHOICLA decision support environment. In Section 3 we report the results of an empirical study which focused on (a) anchoring effects within group decision scenarios and (b) the impact of explanations. The paper is concluded with Section 4.

2 The Choicla Environment

Decision tasks often differ in their basic properties, for example, *decision heuristics* [12] such as *majority voting* or *least misery* should be preselected or not, *alternatives* can only be defined by the administrator (also denoted as *creator*) of a decision task (app), *preferences of other group members* should be visible (or not), and decisions should be *explained* or not (by the creator of a decision task). Due to the many existing options, decision tasks must be configured before being provided to a group of users – for details see Stettinger et al. [19]. An example of a definition (configuration) of a CHOICLA decision app is depicted in Figure 1. In this example, a group of users (stakeholders) should *decide about the priority of requirements that should be additionally implemented in a software project*. In this context, all group members are allowed to add their own alternatives (software requirements), to add additional material (links and files), and to see the preferences of other users (regarding the prioritization of requirements). Making the process design of decision tasks configurable introduces the flexibility that is needed due to the heterogeneity of decision problems. The achieved flexibility provides the basis for organizing the CHOICLA components in a kind of a software product line that is open in terms of the generation (implementation) of problem-specific decision applications.

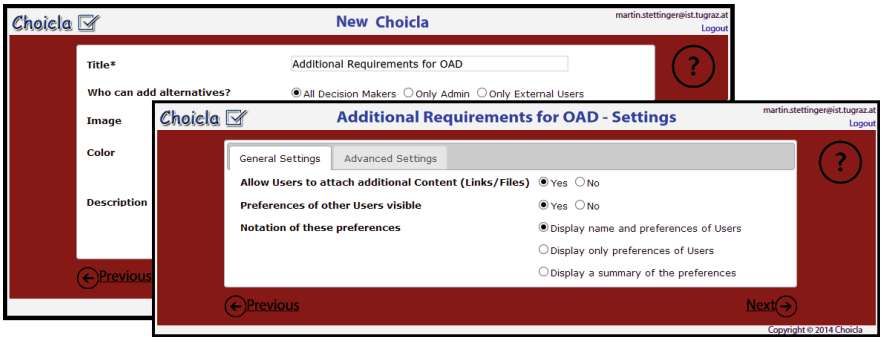

Fig. 1. Interface for configuring CHOICLA decision apps

After a CHOICLA *decision app configuration* has been completed, the corresponding *decision app* is automatically generated and installed on the home

screen of the decision app creator. The creator can now invite relevant users (in our case stakeholders) to participate in the decision process – this is currently possible via email. Figure 2 depicts examples of already configured and generated CHOICLA decision apps: *requirements prioritization* (our working example), *appointment scheduling*, *hardware procurement*, and *personnel decision*[4].

Figure 2 includes two more tabs which are denoted as *DecisionApp Store* and *Create DecisionApp*. The former can be used for searching and installing new decision apps (this is only possible if a decision app has been defined as *public* and therefore been made *reusable* by the app creator), the latter can be used for creating (configuring) your own decision app (for details see Stettinger et al. [19]). CHOICLA decision apps can entail an arbitrary number of decision *instances*, for example, if a requirements prioritization decision has to be taken for a new project or a new set of requirements, the same decision app can be used by simply creating a new instance inside the given decision app. Also after completion of the decision process, each individual instance of the decision app is accessible in a *decision history* (documentation).

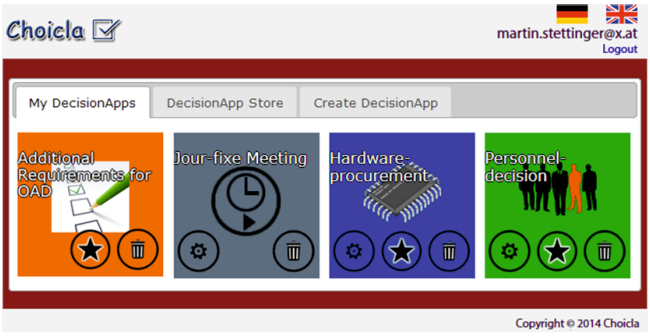

Fig. 2. Examples of defined (configured) and generated CHOICLA decision apps

3 User Study

As already mentioned in Section 1, our major goal is to analyze anchoring effects in group decision scenarios. In a requirements prioritization scenario (team members had to select *additional requirements they had to implement within the scope of their project*) we wanted to investigate the existence of anchoring effects and also to figure out when to best disclose individual preferences (evaluations) to other users (in our case stakeholders). In this context we were also interested in the impact of preference invisibility on the degree of information exchange between individual stakeholders. Finally, we wanted to investigate factors such as the impact of the existence of explanations for group decisions on the degree

[4] The CHOICLA *personnel decision app* is already applied by an Austrian university.

of satisfaction with the decision support and the perceived understandability of the group decision. In the remainder of this paper we will first present the CHOICLA decision app generated for the purposes of requirements prioritization (software requirements for an online game) and then discuss the design of our user study and the corresponding study results in detail.

The generated requirements prioritization decision app supports the prioritization of requirements on the basis of a multi-utility based evaluation scheme [3]. Team members (subjects of the study) were enabled to evaluate each requirement with regard to the dimensions *Risk*, *Effort*, and *Profit*. Note that such dimensions are freely definable in CHOICLA if a MAUT-based aggregation function (group recommendation heuristic) has been selected. An example of the evaluation of the requirement *Change Background* is depicted in Figure 3.

Fig. 3. Evaluation interface of the requirements in CHOICLA. Participants can enter their ratings by selecting a value for the dimensions *Risk*, *Effort*, and *Profit*.

This requirement is linked to a detailed textual description – in our case, the background style should be changeable in an online game. Note that in utility-based scenarios CHOICLA supports a group-based MAUT approach, where individual ratings defined for interest dimensions are aggregated using arithmetic mean and then added up (for details see Stettinger et al. [18]). The utility of each individual alternative (*requirement*) is then transposed to a five-star rating scale as depicted in Figure 3. Since the goal of our study was to investigate anchoring effects in the context of group decision scenarios, the *visibility of the preferences of other group members* was one of the major variation points in the user study.

Figure 3 includes a CHOICLA user interface version where the preferences of other users are not disclosed to the current user. In contrast, Figure 4 depicts an interface version were the preferences (priorities) of the individual stakeholders are visible (the height of each bar corresponds to the corresponding MAUT value [3,18] of a requirement, individual preferences are visible when moving the mouse pointer over the corresponding bar). If all stakeholders have articulated their requirements, the creator of a decision app can close the decision process, i.e., no further changes/adaptations of the individual user preferences are possible from

that time on. Closing the decision process means that one or more options are selected by the administrator and these alternatives altogether then represent the final decision. The selected alternatives may not correspond with the alternatives proposed by the aggregation heuristic (in our case MAUT).

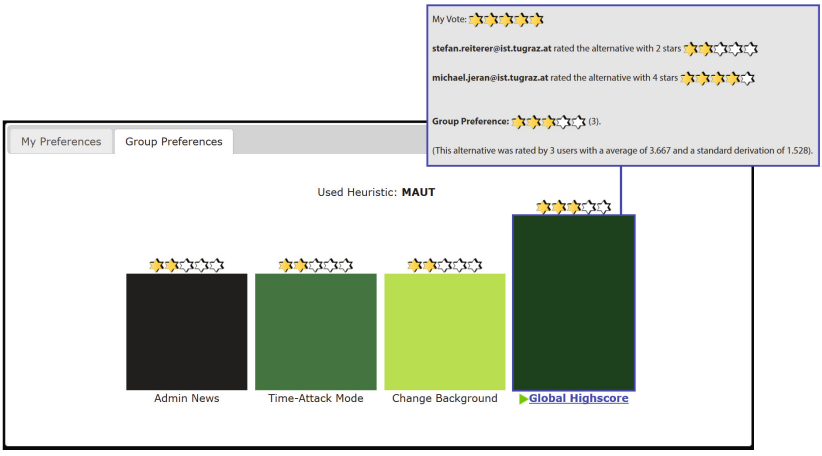

Fig. 4. Group recommendation (on the basis of MAUT values) for the prioritization of requirements within CHOICLA. Preferences of individual stakeholders are disclosed when moving the mouse pointer over the bar.

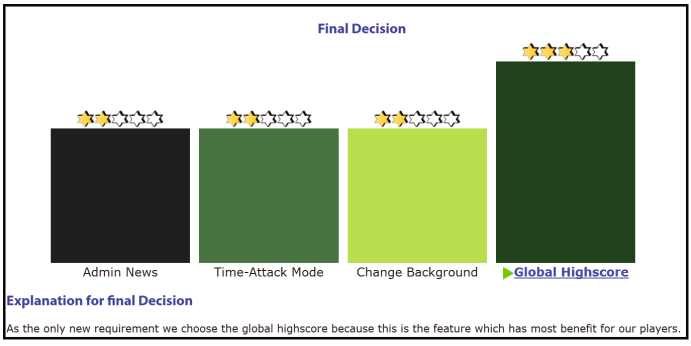

Fig. 5. Representation of a final decision in CHOICLA in terms of a bar chart

In our working example, the creator of the decision app selected only one requirement (*Global Highscore*) as an additional requirement to be implemented in the project (see Figure 5). In this case, the creator follows the group recommendation and also explains the reason for the final decision. Note that the possibility of explaining final decisions is another major variation point in the user study, i.e., some versions included this option, some versions not.

We conducted a user study with computer science students at the Graz University of Technology (N=229 participants, 16% female, and 84% male) who took a course on *object oriented analysis and design*. Students formed software teams with 5–6 participants (in total 45 teams) who had then to implement an online game environment. Each team had to develop the same set of basic requirements but could choose 5 out of a set of 10 additional requirements using CHOICLA as the sole decision and communication platform.[5] The 45 software teams (groups) were assigned to different categories as follows (see also Table 1). First, 23 groups were confronted with a CHOICLA user interface which enforced the explanation of final decisions, the remaining 22 groups had the option to explain their decisions but this was not mandatory. Second, the individual CHOICLA versions differed in terms as of when individual preferences are made public to all group members (after one, two, three, or all group member(s) has(have) articulated his/her(their) preferences).

Table 1. Assignment of versions to groups in the user study, for example, *"explanation mandatory+after 1."* denotes a CHOICLA version with *mandatory explanations* and *individual preferences were disclosed* after one group member defined his/her preferences.

explanation mandatory				explanation not mandatory			
after 1.	after 2.	after 3.	after all	after 1.	after 2.	after 3.	after all
6 groups	6 groups	5 groups	6 groups	6 groups	6 groups	5 groups	5 groups

The hypotheses as input for our user study were the following. First, we assumed that anchoring effects occur especially in cases were preference information of individual users is disclosed although this information has not been provided by all group members, i.e., the lower the number of completed preference definitions the higher the probability of anchoring effects (H1).

Second, we assumed that the best time to disclose individual preferences is a situation where each group member has already articulated his/her requirements (H2). This strategy should lead to the best results regarding (a) *the satisfaction with the final group decision* as well as (b) *the perceived degree of decision support*, (c) *perceived understandability of the final group decision*, and (d) *consideration of one's personal preferences*. In our study, data to answer (a)–(d) were collected in a post-decision questionnaire. The rating scale for questions (a)–(b) was [very satisfied (5) .. very unsatisfied (1)], for question (c) it was [understood immediately (5) .. no chance to understand without asking a couple of times (1)], and for (d) it was [excellent (5) .. very bad (1)].

In the line of decision psychological experiments [9,14] we assume that the later individual preferences are disclosed the higher will be the number of comments in the CHOICLA forum (H3). A higher degree of information exchange also has a direct positive impact on decision quality – see also [9,14]. Hypothesis H3 is related to the fact that groups tend to focus on the preferences of other

[5] Due to space limitations we limited our example set to 3 requirements.

group members if this information is available but otherwise focus on information exchange to gain a better understanding of the problem setting [9,14].

With hypothesis H4 we want to express the assumption that the explanation of a final decision can increase (a) *the satisfaction with the final group decision* as well as (b) *the perceived degree of decision support*, (c) *perceived understandability of the final group decision*, and (d) *consideration of one's personal preferences.*

The results of our user study were the following. We can confirm hypothesis H1, i.e., anchoring effects are triggered by an earlier disclosure of preference information to other group members. In this context, we analyzed the standard deviations of the individual user ratings (i.e., we used the standard deviation of ratings as an indicator of anchoring effects) depending on the time of the disclosure of the ratings (preferences) of individual group members. Figure 6 depicts the standard deviations of user ratings depending on the time of preference disclosure; standard deviations increase monotonously in the number of anonymously articulated preferences. The series of standard deviations related to versions *after 1.* and *after 2.* (and above) significantly differ in terms of their mean values ($p < 0.05$, t-test).

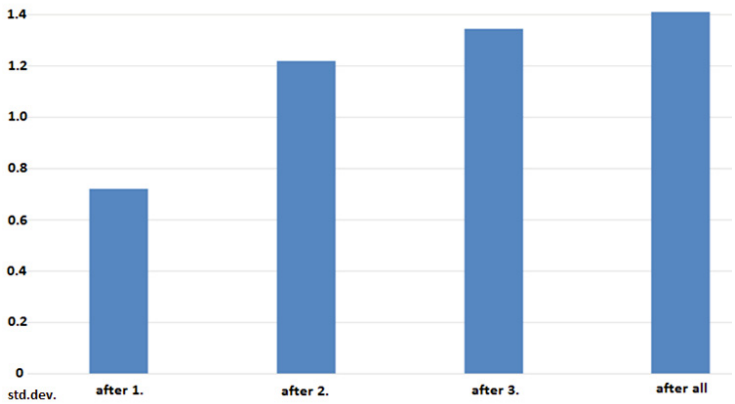

Fig. 6. Standard deviations of user ratings of alternatives (requirements) depending on preference disclosure time (after 1..3, or all users articulated preferences)

We can also confirm hypothesis H2. The later the time of preference disclosure (the more group members have articulated their preferences without viewing the preferences of other users), the higher the evaluation with regard to the dimensions (a) satisfaction with the final group decision, (b) perceived degree of decision support, (c) perceived understandability of the final group decision, and (d) consideration of one's personal preferences. Figure 7 depicts, for example, the user evaluations with regard to (a) satisfaction with final group decision and (b) perceived degree of decision support. The average evaluations of all dimensions, i.e., (a) .. (d), are depicted in Table 2.

T-tests also confirm significant user evaluation improvements with an increasing number of defined but undisclosed preferences. The average user evaluations regarding (a) and (b) related to versions *after 1.* and *after 3.* (and above) differ in terms of their mean value ($p < 0.05$, t-test, see also Figure 7). Significant results ($p < 0.05$, t-test) could also be observed for average user evaluations regarding (c) and (d) related to versions *after 1.* and *after all.*

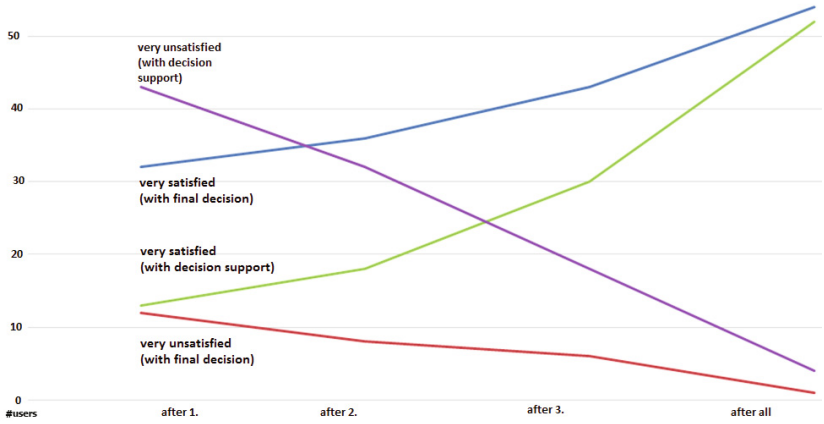

Fig. 7. *Satisfaction with final group decision* and *perceived degree of decision support* depending on preference disclosure time (after 1..3, or all users articulated preferences)

Table 2. Avg. evaluations and std.dev. regarding (a) satisfaction with the final group decision, (b) perceived degree of decision support, (c) perceived understandability of the final group decision, and (d) consideration of one's personal preferences

	All			
	after 1.	after 2.	after 3.	after all
a	2.87(1.67)	3.01(1.5)	3.31(1.19)	3.73(0.73)
b	1.75(1.77)	2.2(1.62)	2.83(1.59)	3.72(1.02)
c	3.44(1.65)	3.54(1.54)	3.79(1.22)	4.04(0.81)
d	3.02(1.77)	3.55(1.75)	3.91(1.46)	4.16(1.04)

We can confirm hypothesis H3: the later individual preferences are disclosed to other users, the higher the amount of comments/discussions in the CHOICLA forum. The number of comments depending on the degree of already available preference definitions not disclosed to other users is shown in Figure 8.

Finally, we can also confirm hypothesis H4: groups with (enforced) explanation support for group decisions have significantly higher evaluations in terms of the dimensions (a) satisfaction with the final group decision, (b) perceived degree of decision support, (c) perceived understandability of the final group decision,

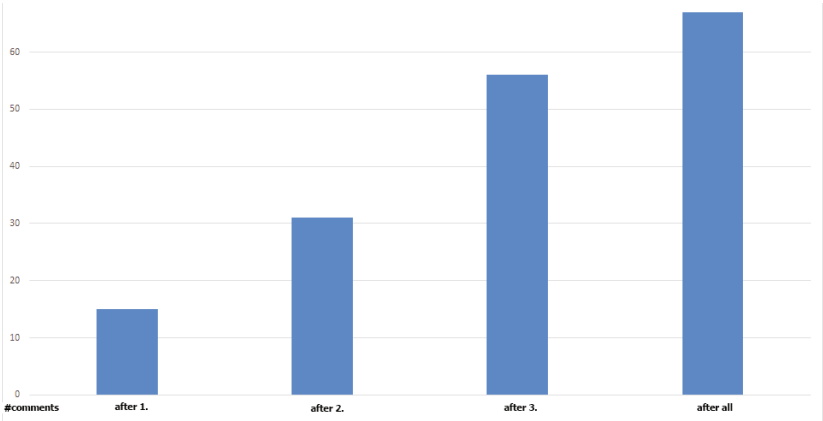

Fig. 8. Number of comments in the CHOICLA discussion forum depending on preference disclosure time (after 1..3, or all users articulated preferences)

and (d) consideration of one's personal preferences. This is confirmed by corresponding t-tests ($p<0.05$) when comparing groups with and without (enforced) explanation support (average evaluations are depicted in Table 3).

Table 3. Avg. evaluations and std.dev. regarding (a) satisfaction with the final group decision, (b) perceived degree of decision support, (c) perceived understandability of the final group decision, and (d) consideration of one's personal preferences

	Explanations Enforced				Explanations Not Enforced			
	after 1.	after 2.	after 3.	after all	after 1.	after 2.	after 3.	after all
a	3.67(1.27)	4.01(1.15)	4.31(0.89)	4.93(0.23)	2.4(1.76)	2.87(1.66)	3.17(1.47)	3.22(1.33)
b	1.95(1.66)	2.5(1.51)	3.45(1.19)	4.69(0.82)	1.63(1.94)	2.02(1.82)	2.67(1.63)	3.18(1.47)
c	3.84(1.35)	3.94(1.24)	4.29(0.92)	4.87(0.41)	3.12(1.72)	3.25(1.78)	3.57(1.58)	3.73(1.22)
d	3.62(1.37)	3.95(1.15)	4.41(0.66)	4.86(0.31)	2.88(1.96)	3.17(1.81)	3.29(1.73)	3.87(1.4)

4 Conclusions and Future Work

With the work presented in this paper we have shown the existence of anchoring effects in group decision scenarios: the earlier individual user preferences are disclosed to other group members, the higher the probability of the occurrence of anchoring effects. The time of preference disclosure also has a direct impact on the perceived quality of the decision outcome and the perceived decision support. Furthermore, late preference disclosure can lead to a higher discussion intensity inside a group which can have a direct positive impact on the quality of the decision outcome. It is important to take into account these aspects in application development; especially one has to analyze the need of preference disclosure since

non-disclosed preferences can help to significantly improve decision quality. The analysis of further decision biases and their impact on group decision making is within the major focus of our future work since this will help to further advance the quality of group decision support in the CHOICLA environment. With regard to anchoring effects we want to analyze in further detail the impact of different representation types of user preferences (e.g. aggregated representations vs. user-specific representations) on evaluation dimensions such as perceived decision quality and quality of decision support. Finally, we are also interested in a deeper understanding of intra-group dynamics that can potentially help to further improve the quality of group decisions.

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