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Klaus Goffart

Michael Schermann

Santa Clara University, mschermann@scu.edu

Christopher Kohl

Jörg Preißinger

Helmut Krcmar

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Using the Default Option Bias to Influence Decision-Making While Driving

Klaus Goffart (Corresponding), BMW Group Research and Technology GmbH, Munich
Hanauer Str. 46, 80992 München, Germany, +49 89 382 16356, klaus.goffart@bmw.de

Michael Schermann, Technische Universität München, Munich
Chair for Information Systems, Boltzmannstr. 3, 85748 Garching, Germany
+49 89 289 19507, michael.schermann@in.tum.de

Christopher Kohl, Technische Universität München, Munich
Chair for Information Systems, Boltzmannstr. 3, 85748 Garching, Germany
+49 89 289 19519, christopher.kohl@in.tum.de

Jörg Preißinger, BMW Group Research and Technology GmbH, Munich
Hanauer Str. 46, 80992 München, Germany, +49 89 382 14038, joerg.preissingen@bmw.de

Helmut Krcmar, Technische Universität München, Munich
Chair for Information Systems, Boltzmannstr. 3, 85748 Garching, Germany
+49 89 289 19532, krcmar@in.tum.de

Abstract

Gaining a better understanding of human-computer interaction in multiple-goal environments, such as driving, is critical as people increasingly use information technology to accomplish multiple tasks simultaneously. Extensive research shows that decision biases can be utilized as effective cues to guide user interaction in single-goal environments. This paper is a first step towards understanding the effect of decision biases in multiple-goal environments. We analyzed data from a field experiment during which we compared drivers' decisions on parking lots in a single-goal environment with drivers' decisions in a multiple-goal environment when being exposed to the default option bias. We show that the default option bias is effective in multiple-goal environments. Our results have important implications for the design of human-computer interaction in multiple-goal environments.

Keywords: decision bias, default option, multiple-goal environment, driving, decision attitude

Introduction

Car manufacturers, traffic officials, and city planners are interested in ways to influence the decision-making of drivers in every-day driving tasks such as looking for a parking space. Aids in decision-making could reduce cognitive load while performing such driving tasks (Häubl & Trifts, 2000).

The role of decision biases has been extensively studied in the field of economics (Johnson et al., 2012) and has also found its way to the human-computer interaction literature (M. Lee, Kiesler, & Forlizzi, 2011). Extensive research shows that decision biases can be utilized as effective cues to guide user interaction. However, there is a paucity of research on the role of decision biases in multiple-goal environments such as driving (Harvey, Stanton, Pickering,

McDonald, & Zheng, 2011). This paper is a first step towards understanding the role of decision biases in multiple-goal environments.

We analyzed data from a field experiment during which we investigated drivers' decisions on selecting parking lots in a single-goal environment (while sitting at a desk) and a multiple-goal environment (while driving). Making a decision on selecting a parking lot while sitting at a desk is likely to induce a hypothetical bias. This bias is already well-researched (Murphy, Allen, Stevens, & Weatherhead, 2005). Therefore, we designed the experiments in a way to minimize the hypothetical bias so the differences in decision-making could be attributed to single-goal and multi-goal environments. We show that a fairly simple implementation of the default option bias can be effectively utilized to guide a driver's behavior. Because attempts to influence a driver's decision may cause distrust, we also investigated effects of the default option bias on the decision attitude of drivers.

The remaining sections of this paper are structured as follows: First, we present the theoretical background on the default option bias followed by the hypotheses development. Second, we describe our field experiment design and procedures and present our results. Third, we perform a post-hoc analysis to compare the results on the effect of decision biases in single-goal environments with the results in multiple-goal environments. Lastly, we discuss the study results, their limitations, and their implications for theory and practice.

Theoretical Background

Decision biases have been extensively studied in the literature on recommender systems. For instance, Johnson and Goldstein (2003) find the effective organ donation consent rate in countries with an opt-out policy, i.e. the default is to be a donor, to be more than 60% higher

than in opt-in countries, i.e. the default is not to be a donor. This phenomenon is known as the *default option effect* (Thaler & Sunstein, 2008). Human beings have a preference for choosing a given default option compared to choosing other options (Dinner, Johnson, Goldstein, & Liu, 2011). Default options have been shown to be effective in many areas of application such as investment (Cronqvist & Thaler, 2004; Madrian & Shea, 2001), insurance (Johnson, Hershey, Meszaros, & Kunreuther, 1993), and marketing (Goldstein & Johnson, 2008).

The default option effect is closely related to the status quo bias studied in the behavioral economics literature (Eidelman & Crandall, 2009). The status quo bias describes the tendency of individuals to disproportionately stick with already chosen or preset options (Samuelson & Zeckhauser, 1988). The status quo bias also has been shown to be effective in a wide range of applications, such as electric power contracts (Hartman, Doane, & Woo, 1991), automobile insurance (Kahneman, Knetsch, & Thaler, 1991), or air fleet leasing (Samuelson & Zeckhauser, 1988).

Research Framework

While extensive research shows that decision biases serve as effective cues to guide user interaction in single-goal environments, there is a paucity of research on the effect of decision bias in multiple-goal environments. Only Bader, Siegmund, et al. (2011) casually note that nearly half of their study participants selected the first item in a list of recommended items while driving. Our study is a first step towards better understanding decision biases in multiple-goal environments. We used the case of finding and choosing a parking lot while driving as a prominent example of a multiple-goal environment. In our study, drivers were presented with a recommender system that suggests parking lots; our dependent variable was the amount of

money spent on parking. We manipulated the recommender system to implement the default option effect towards higher-priced parking lots and observed differences in parking lot choices in a single-goal environment (sitting at a desk) and in a multiple-goal environment (while driving).

First, in line with literature, we hypothesized that evoking a default option bias increases the amount paid on parking lots in both single-goal environments and multiple-goal environments:

H1 – Utilizing a default option bias towards more expensive parking lots is associated with higher expenditures for parking in both a single-goal environment and a multiple-goal environment compared to not utilizing a default option bias.

Second, we wanted to investigate if the use of the recommender system while driving affected the decision attitude of the participants. For instance, Häubl and Murray (2005) find that buyers in a single-goal environment show little resistance to choice architectures even when the influence directly benefits the sellers. Confronting participants with recommendations might, however, influence customer satisfaction. Therefore, we hypothesized:

H2 – While driving, utilizing the default option bias is associated with lower decision attitudes compared to not utilizing the default option bias.

In addition to the two hypotheses presented above, we also evaluated the decision differences in the single-goal and the multiple-goal environments in a qualitative post-hoc analysis.

Method

In order to test our hypotheses, we used two repeated measures studies to investigate the default option bias in a single-goal environment and in a multiple-goal environment. We implemented a simple recommender system for investigating decisions on parking lots in a single-goal environment (sitting at a desk) and in a multiple-goal environment (while driving). We chose a very simple design (Figure 1) to avoid any effects from a more elaborate visualization of parking lots.

Treatment

The recommender system offers three parking lot options. Each parking lot comes with a price tag and the walking distance to destination shown in meters and walking time. Table 1 shows a summary of the offered parking lots. A budget parking lot is offered for €2.50 with a walking distance of 400 meters to the destination. For every 200 meters closer to the destination, the price of the parking lot increases by €1.00. Thus, a medium priced parking lot for €3.50 requiring 200 meters of walking and an expensive parking lot for €4.50 with no walking distance to the destination are offered. Both the reference point for the price of parking lots and the ratio of walking distance to price were selected according to the market value and verified in an online survey using a conjoint analysis (Orme, 2010) with 51 participants.

We implemented the default option bias in our simple recommender system using the following rationale. Each participant used the recommender system twice in both the single-goal environment and the multiple-goal environment. The first run-through of the system revealed the preferences of the participant. The second run-through included the default option bias to influence the decision on choosing the parking lot. Thus, each participant was required to make

four decisions on parking lots: two in the single-goal environment and two in the multiple-goal environment.

In more detail, the recommender system first offers the three parking lots at random, without recommending a specific parking lot, in order to identify the baseline preferences of our participants. When using the recommender system for the second time, we implemented the default option bias. The recommender system offers the same three parking lots and recommends the next expensive parking lot compared with the previous parking lot decision. In cases where the participant had chosen the most expensive parking lot in the baseline run, the recommender system recommended the next less expensive option. These cases were discarded when testing our hypotheses.

Three main antecedents drive the default option effect (Dinner et al., 2011). First, the lower physical effort required to respond to the choice task by selecting the default (Tversky & Kahneman, 1974). Thus, we showed the recommended parking lot pre-selected at the top of the list of parking lot options to reduce the physical effort of choosing this option. Second, the lower cognitive effort due to the implied endorsement, i.e. the user interprets the default option as a sincere recommendation (Brown & Krishna, 2004). Thus, we framed the suggested parking lot as recommended in the accompanying description. Third, the default option is characterized as a reference point or status quo leading to the endowment effect (Kahneman, Knetsch, & Thaler, 1990). Therefore, the description accompanying the recommended parking lot states that this is the currently selected parking lot whereby it is framed as the status quo.

Treatment in the Single-goal Environment

In the single-goal environment, the recommender system was embedded in an online questionnaire. The participants were instructed to choose their preferred parking lot and thus find a trade-off between the price of the parking lot and the walking distance. The parking lot decision was recorded using standard radio buttons. In order to avoid sequence effects, the parking lots were presented at random. We included several other parking lot choices to avoid memory effects before presenting the same set of parking lots again with a recommend parking lot. The recommended parking lot was positioned as the first option, the radio button was pre-selected, and the text framing the parking lot as the status quo was added. All parking lot choices in the questionnaire were hypothetical ones, i.e. the participants did not have to pay for the parking lot nor did they have to walk the corresponding distance. A short scenario description was included in the questionnaire to create a situation similar to the one encountered in the multiple-goal environment.

Treatment in the Multiple-goal Environment

In the multiple-goal environment, making decisions about parking lots is a secondary task for the driver because it is not directly related to operating a vehicle (Hedlund, Simpson, & Mayhew, 2006). To control for any safety related effects, we implemented the recommender system using automatically triggered recommendations. In addition, the recommender system was integrated in the standard in-vehicle information system (IVIS) of the vehicle. The experiment supervisor triggered the presentation of the parking lots using a smart phone hidden from the participant.

Figure 1 depicts the parking lot list displayed on the IVIS during the first trip. The IVIS always preselects the first item but it does not recommend a parking lot in this case. The system chooses the order of the parking lots randomly to prevent effects through pre-selection. Figure 2 shows the parking lot list during the second trip. The first item on the list is always the recommended lot. It is preselected and is supplemented by a text framing it as the current status quo. The remaining two offers are displayed in random order. After the participants selected a parking lot using the car's integrated jog dial controller, the navigation system was automatically programmed to a target at the selected distance to the destination.

After each trip, the participants answered a short in-car questionnaire in order to measure the participants' satisfaction with the parking lot decision using the Decision Attitude Scale (DAS) (Sainfort & Booske, 2000). The DAS was developed in order to measure satisfaction with a decision after a choice has been made, particularly in situations where a decision cannot be classified as right or wrong. The DAS comprises a series of 10 questions and a 5-point Likert scale for the answers. We deleted one question because it did not fit the parking lot use case, a common procedure for a multiple item construct (Xu, Lin, & Chan, 2012). In order to measure the participants' attitude with the chosen parking lot option, the questions were adapted to the parking lot use case and translated (see Table 2). The overall DAS score is the average of the scores for every question after transforming the negatively framed questions: a score of one indicates very poor decision satisfaction and five indicates very high decision satisfaction.

Procedure

Participation in the study comprised four steps: registration, filling out a questionnaire, a first trip and a second trip. We required each participant to have an off-site work meeting in

order to ensure a close to reality situation. In this way, participants would have to actually experience the consequences of their decisions.

After registering for the experiment, each participant was sent a link to an online questionnaire to be completed before the field experiment started. This questionnaire corresponded to the single-goal environment in that participants were instructed not to perform any additional tasks while completing the questionnaire. Embedded in the questionnaire was the single-goal implementation of the default option bias. In addition to the parking lot choices, the participants were also asked to provide demographical information.

Next, the supervisor introduced the participants to the in-vehicle information system and each participant was given an example parking lot offer to become familiar with the experiment. The experiment supervisor gave the participants a compensation payment of €9.00 for participating in the two trips and informed the participants that parking lot fees were to be paid using this compensation payment and they were expected to actually walk any distance indicated. Participants were also told that they had to take the selected parking lot even if they knew of other alternatives or saw better alternatives at their destination.

During each trip, the participant drove the car with the supervisor sitting on the passenger seat. While driving, the supervisor triggered the parking lot offer corresponding to the current trip, i.e. without a recommendation on the first trip and with a recommendation on the second trip. The participant selected one of the offers and stopped the car at the corresponding walking distance to the destination. Before exiting the vehicle, the participant answered the in-car questionnaire and paid the amount due for the parking. The participant then walked the remaining distance to their destination.

The entire procedure was pretested with 4 participants before starting the experiment in order to verify the experimental setting and the questionnaires used.

Participants

The field experiment was conducted with 34 employees of a local car manufacturer: 5 (15%) female and 29 (85%) male participants. The average participant age was 32 years and age ranged from 24 to 52 years. Of the 34 participants, 10 (29%) were Ph.D. students, 23 (68%) were employees and 1 (3%) was a supervisor at the car manufacturer.

Results

Single-goal Environment

In order to validate the effectiveness of the default option effect in a single-goal environment, we needed to compare the decision results from the questionnaire implementation of the recommender system. Two participants chose the most expensive parking lot in the first run and were therefore excluded from the analysis. Thus, results were obtained from 32 of the 34 participants. Figure 3 shows that 20 (63%) participants chose the budget and 12 (37%) participants chose the medium cost option resulting in an average spending of €2.88 per participant (see column “Single-goal – Baseline”, Figure 3).

With the default option bias in effect, 16 (50%) participants opted for the budget parking lot, 13 (41%) for the medium-priced lot, and 3 (9%) for the expensive parking lot (see column “Single-goal – Default Opt“, Figure 3). The average spending was €3.09. Having the default option bias in effect increased the average spending on parking by €0.22. Using an exact

Wilcoxon signed-rank test (Siegel, 1956), we found the spending with the default option present to be significantly higher ($p = 0.020$, $Z = -2.333$) than spending in the baseline run.

Multiple-goal Environment

In the multiple-goal environment, two participants chose the expensive parking lot option in the baseline run. Thus, we again only considered 32 of the 34 participants. 15 (47%) participants chose the budget option while 17 (53%) participants chose the medium-priced option (Figure 3, column “Multiple-goal – Baseline”). As described in the method section, the first parking lot option presented in the baseline run has been preselected by the IVIS. Still, the participants did not choose this option more often compared to the other available options. The average spending was €3.03 per parking lot. With the default option bias in effect, 11 (34%) participants chose the budget option, 15 (47%) chose the medium-priced option and 6 (19%) chose the expensive parking lot option (Figure 3, column “Multiple-goal – Default Opt”). The average spending was €3.34 per parking lot. Therefore, having the default option bias in effect increased the average spending by €0.31. Using an exact Wilcoxon signed-rank test (Siegel, 1956), we found the spending for parking with the default option present to be significantly higher ($p = 0.025$, $Z = -2.055$) than in the baseline run.

Decision Attitude

We used the data from all 34 participants to evaluate the decision attitude of the participants, as the decision attitude scale does not reflect particular spending behavior. The decision attitude scores varied between 2.66 and 4.88 at baseline run and between 3.33 and 5 with the default option bias in effect. The averages were 4.127 (variance 0.314) for the baseline

run and 4.180 (variance 0.156) with the default option bias in effect. The average decision attitude is slightly higher when utilizing the default option bias than in the baseline, but only by a margin of about 0.052 points (about 1% of the overall scale). Using an exact Wilcoxon signed-rank test (Siegel, 1956), we found no significant difference in decision attitudes between the baseline run and the default option run ($p = 0.901$, $Z = -133$).

Post-Hoc Analysis

In order to predict the strength of the default option bias in the multiple-goal environment, it is interesting to compare the effectiveness of the default option bias in the single-goal environment to the effectiveness in the multiple-goal environment. However, the experiment was not designed to compare the two environments and we therefore present these findings as a post hoc analysis. Due to the experimental setup, additional limitations apply to the presented results.

The average spending increase in the presence of the default bias was €0.221 in the single-goal environment compared to €0.31 in the multiple-goal environment. Thus, for each participant the spending in the multiple-goal environment was €0.09 higher than in the single-goal environment. Figure 4 visualizes the spending increase between the different runs and environments. The post-hoc analysis was performed in an attempt to identify the reason for this higher spending.

In the following, we first list the limitations that apply to the post-hoc analysis. Afterwards, we examine the occurrence of several decision patterns in the single-goal environment and in the multiple-goal environment. Lastly, we investigate the influence of contextual factors on the parking lot selection.

Limitations of the Post-Hoc Analysis

When comparing the effect of the default option in the single-goal environment and in the multiple-goal environments, we have to keep in mind that the study was not designed to compare single-goal and multiple-goal environments. Thus, not only the environment changed from single-goal to multiple-goal environment but several other factors as well. Table 3 provides a detailed overview of the differences between the environments. The main differences between these two situations are the user interface, hypothetical decisions in the single-goal environment, supervised design in the multiple-goal environment, and the contextual influences present in the multiple-goal environment.

The user interface in the single-goal environment was a web view with a pointing device used for interaction as is commonly found on desktop computers. By contrast, the in-car interface used a list view in combination with a jog-dial controller for user interaction. This difference might have caused a bias in the collected data: we did attempt to minimize any differences by using a very similar layout in both environments.

In contrast to the multiple-goal environment, the participants did not have to face the consequences of their decision, i.e. pay parking fees or walk, in the single-goal environment. The resulting difference in decisions is known as hypothetical bias (Bohm, 1972). Hensher (2010) investigated the hypothetical bias for choice experiments, finding the hypothetical to actual ratio to be between 0.838 and 1.67. While Murphy, Allen, Stevens, and Weatherhead (2005) find the hypothetical bias to be well researched, they also comment that it is difficult to estimate its effect and correct for it. Therefore, we chose to use the collected data “as is” for our ongoing analysis instead of trying to correct for a possible hypothetical bias which might lead to further inaccuracies. Additionally, we tried to reduce the hypothetical bias by explicitly stating that

parking lot fees would have to be paid in the given scenario and giving examples for walking distances in the single-goal version of the recommender system.

While the single-goal environment was unsupervised, a supervisor was present in the multiple-goal environment to manually operate the recommender system. This difference might have had an effect on the participant's decision.

Since the multiple-goal environment was a field experiment, the contextual influence factors varied from trip to trip. We tried to compensate for the missing contextual influences in the single-goal environment by framing the participant into a situation similar to the one encountered in the field experiment.

Lastly, all participants went through the single-goal environment before going through the multiple-goal environment, which might have led to order effects. This sequencing of events was necessary in order to maximize the time span between the environments and, thus, to minimize the effect of participants remembering the previously chosen parking lot. In this way, we integrated the single-goal environment into the registration process that usually took place about a week before the multiple-goal environment. We asked the participants if they remembered their answers from the single-goal environment and did not find an effect.

Decision Patterns

In order to study the influence of a recommendation on the participant decision, we examined the participants who selected the recommended parking lot and subsequently followed the recommendation. We grouped these participants into three categories based on their parking lot decision pattern: *Consistent* participants (those who chose the same parking lot with and without a recommendation); *Influenced* participants (those who chose the recommended parking

lot; *Inconsistent* participants (those who chose the remaining parking lot that was neither recommended nor previously chosen). Figure 5 shows an example of the grouping of the participants into consistent, influenced, and inconsistent for a participant that chose the medium-priced parking lot option in the baseline run.

By grouping the participants this way, we can compare the participants' reaction to the recommender system in the single-goal environment and in the multiple-goal environment. Since we are no longer considering customer spending, data from all 34 participants are included in the following discussion.

In the single-goal environment, 25 (73%) participants were consistent in their selection: they selected the same parking lot with and without recommendation. Eight (24%) participants were influenced: they selected the recommended parking lot whereby 1 (3%) participant was inconsistent and did not select the same parking lot twice nor followed the recommendation.

In the multiple-goal environment, 18 (53%) participants were consistent, 9 (26%) participants were influenced, and 7 (21%) participants were inconsistent. Figure 6 illustrates the proportion of changed decisions for the single-goal and multiple-goal environments.

Comparing the single-goal and multiple-goal environments, 27 participants in the multiple-goal environment versus 34 in the single-goal environment made a consistent choice. Furthermore, 7 participants made an inconsistent choice, boosting the inconsistent share from 3% in the single-goal environment to 21% in the multiple-goal environment. In summary, a greater number of participants made an inconsistent choice during the multiple-goal environment than during the single-goal environment.

This increase in inconsistent participants is the cause for the greater increase in spending in the multiple-goal environment. The cumulative spending of the participants grouped into

consistent, influenced, and inconsistent for the single-goal and multiple-goal environments and with and without using the recommendation system is shown in Table 4. In both the single-goal and the multiple-goal environment, participants in the influenced group caused a rise in the total parking lot expenses of €8.00. The participants in the inconsistent group decreased their total parking lot expenses by €1.00 in the single-goal environment but increased expenses by €2.00 in the multiple-goal environment. This corresponds to a spending increase of €0.09 per participant from the single-goal to the multiple-goal environment. Thus, the increased parking lot expenses result from the inconsistent decisions.

Given these findings, it seems that the multiple-goal environment did not have an effect on the number of influenced choosers, as their expenses remained relatively stable.

Contextual Influence Factors

The number of participants identified as inconsistent choosers rose dramatically between the single-goal and the multiple-goal environment. We used an exact McNemar's test (Siegel, 1956) to find a significant difference in inconsistent choosers between the single-goal and the multiple-goal environment ($p = 0.031$). Since the single-goal environment was hypothetical, the external influences are stable and, therefore, the real world environment and its changing contextual influences might have caused the larger number of inconsistent choosers in the multiple-goal environment.

In order to identify a possible cause for the increase in inconsistent participants, we had a closer look at the recorded contextual factors in the multiple-goal environment. Since the experiment was conducted as a field experiment, we were not able to control the contextual factors for each participant although we did try to record all factors that might have had an

influence on the decision outcome. In Goffart, Schermann, Kohl, Preißinger, and Krcmar (2014) we reported that *urgency* and *willingness to walk* have a significant influence on parking lot decisions. Therefore, we further investigated the influence of these two factors on the decision behavior of the inconsistent participants in the multiple-goal environment.

After each decision (the baseline and the default option bias decision), we asked the participants to state the reasons for their choice and coded the answers if they contained any clue on urgency (lack of time was an issue), and willingness to walk (walking desire was an influencing factor).

Of the 34 participants in the multiple-goal environment, we only considered the 7 participants who had made an inconsistent decision. Figure 7 shows a detailed visualization of urgency as a decision influence factor (columns) and the resulting decisions (rows). Each of the 7 inconsistent participants is represented by a square shape, indicating the decision in the baseline run which is connected to a diamond shape, indicating the decision with the default option present. Of these 7 inconsistent participants, 3 selected the budget option in the baseline run and the expensive option when the default option bias was present thus ignoring the recommended medium-priced option and choosing the most expensive one. All 3 participants reported no feelings of urgency during the baseline run but did experience urgency during the default option run. Thus, we can explain this behavior with the influence of urgency on the parking lot decision. The remaining 4 inconsistent participants chose the medium-priced option during the baseline run and the budget option during the default option run and ignored the recommended expensive parking lot. Urgency changed between the baseline and default option runs for only 1 of the 4 participants; from not mentioning urgency in the baseline run and selecting the medium-priced option, to no urgency when the default option bias was present and selecting the budget option.

Therefore, urgency seems to have affected the decision change for this participant. None of the remaining 3 participants mentioned urgency as a reason for their decisions in either run. Thus, we found urgency to be a factor for the choice of parking lot for 4 of the 7 inconsistent participants.

Figure 8 illustrates the influence of the willingness to walk on the inconsistent participants. 3 of the 7 participants in the inconsistent group chose the budget option in the baseline run and the expensive option in the default option run; only one of the 3 mentioned a switch from willing to walk to not willing to walk as the reason for the selection. The remaining 4 participants chose the medium-priced option in the baseline run and the budget option when the default option bias was present. Only 1 participant did not mention walking as a reason for the decision in both runs. 2 participants stated that they did not wish to walk in the baseline run but did not state any walking preferences in the default option run, which might support a desire to walk as an influencing factor for these 2 participants. 1 participant did not state any walking preferences in the baseline run choosing the medium-priced option and indicated walking desire in the default option run choosing the budget option. Thus, we found the desire to walk to be an influencing factor supporting the decision for 4 of 7 participants in the inconsistent group.

In summary, contextual factors supported the decisions of 6 of the 7 participants that made an inconsistent choice.

Discussion

In this section we discuss the results for the two hypotheses presented in the Results section and the post-hoc analysis. We conclude by listing the limitations of our work and summarizing the implications for theory and practice.

Hypothesis H1

The presented results verify that the default option bias towards more expensive parking lots is associated with higher expenditures in the single-goal and the multiple-goal environments.

By accepting hypothesis H1 for the single-goal environment, we validate the effectiveness of the implemented default option bias in a controlled, single-goal, and hypothetical environment which is in accordance with the current state of research in the field of choice architectures (Johnson et al., 2012) and decision aids (Li, Zhu, Zhang, Wu, & Zhang, 2013; Xiao & Benbasat, 2007). Most of the literature shows the effect of default options for complex decisions with a rather large set of options and attributes that have a great impact on users' lives, such as social security investments (Cronqvist & Thaler, 2004; Madrian & Shea, 2001) or organ donation (Johnson & Goldstein, 2003). By contrast, we used a minimalistic approach of recommendation by showing only three choice options with two attributes each for the rather short-termed problem of finding a suitable parking spot.

By accepting hypothesis H1 for the multiple-goal environment, we confirm the effectiveness of the default option bias in a multiple-goal environment. This substantiates the very sparse literature available mentioning the effect of decision biases in multiple-goal environments (Bader et al., 2011). To the best of our knowledge, we were the first to specifically design an experiment to show the effectiveness of the default option effect in a real world, multiple-goal environment. The presented findings might also have an effect on road safety as the recommender system is a simple decision aid known to reduce the cognitive load of the decision maker (Häubl & Trifts, 2000; Todd & Benbasat, 1994). A decreased cognitive load may possibly reduce distractions and enhance driving performance (Truschin, Schlachtbauer, Zauner,

Schermann, & Krcmar, 2011). Car manufacturers can use these findings to design in-car recommender systems that guide the user (driver) to making good decisions and reduce distraction-related risks.

Hypothesis H2

The presented results do not show any significant effect of the default option bias on the decision attitude of participants. In addition, none of our participants mentioned any notion of the applied default option to the study supervisor. These findings are in accordance with the available single-goal environment literature which suggests individuals show little resistance to the influence of decision biases (Häubl & Murray, 2005; Johnson et al., 2012). Thus, it seems like nudging customers towards preferred decision outcomes does not directly affect customer satisfaction. It might be possible, on the other hand, to use decision biases to guide drivers to unwanted decisions, leading to ethical implications as discussed in Smith, Goldstein, and Johnson (2013).

Post Hoc Analysis

We may well be the first to present data comparing the effectiveness of the default option in a single-goal environment with the effectiveness in a multiple-goal environment. Though additional limitations apply, it seems the default effect is as strong in the multiple-goal environment as in the single-goal environment. One might think that based on these results, hypothetical questionnaire studies should be sufficient to evaluate the effect of decision biases and recommender systems, but we found that the real word situation in our multiple-goal environment had a huge impact on the participants' decision. It is important to gain a deeper

understanding of these contextual influences that alter customer preferences in order to generate accurate recommendations and understand the impact of decision biases in these situations.

Limitations

The first limitation of this study is the low number of participants in our experimental setting; it may be difficult to generalize results stemming from 34 participants to a broader population. This is especially a problem for the wide-ranging contextual factors that we identified in the post hoc analysis. However, using appropriate statistical methods we feel the results are validated on the selected sample. The second limitation is that further research is necessary to apply the results to the practical design of in-car recommender systems due to the large amount of contextual factors. However, the effect of the default option seems to be stable even under varying contextual influences. Third, the sample of participants might be biased due to their being chosen from the research department of an automobile manufacturer. Hence, our sample is not representative for the population. Lastly, the recommender system design required a participant's decision without recommendation to take place prior to a decision with a recommendation. This situation might lead to sequence effects.

Conclusion

The prediction by Walker, Stanton, and Young (2001) that internet connection in cars will be commonplace in 2015 has actually happened. Today's cars are usually equipped with Internet connection at least for telematics or emergency purposes. Walker et al. (2001) also predicted that cars will offer "advice on parking availability [...] once the final destination is reached". Indeed, modern cars offer online services providing information about parking opportunities close to a

given destination (Audi, 2013; BMW, 2013; Mercedes-Benz, 2014). These in-car recommender systems are commonly used while driving, i.e. in a multiple-goal environment. Thus, research on basic principles of human-computer interaction in this different environment is needed (Manner, Kohl, Schermann, & Krcmar, 2013; Truschin, Schermann, Goswami, & Krcmar, 2014).

To the best of our knowledge, these results are the first to show that using a simple default option can change drivers' decision making in a real-world, non-hypothetical, multiple-goal environment. One might think that drivers perceive this kind of influence as bogus, but we found no measureable difference in decision attitude. This knowledge can be applied in a multitude of ways: drivers can be guided to make decisions enhancing the public good, like walking a bit longer to reduce traffic in congested areas during rush hour, or simply take a parking lot that is a little further from their destination to improve their health by walking. Of course there are economic implications of these findings such as promoting premium choices with higher values, although this may lead to ethical implications as discussed in Smith, Goldstein, and Johnson (2013).

Because the default option effect is not tied to recommendations but to all decisions, designers of in-vehicle user interfaces have to be aware of the effect of the default option when designing user interfaces. Further research is needed on the effect of using a default option on driver distraction as literature suggests that decision aids can reduce the cognitive load (Todd & Benbasat, 1994) and might, therefore, increase driving performance (Chang, Hwang, & Ji, 2011; J. Lee, Forlizzi, Hudson, & Jun, 2014).

By performing a post-hoc analysis of the collected data, we found contextual factors strongly influenced the real world environment of the field experiment. Researchers working on in-car recommender systems should use field studies to collect information on these contextual

influences and concentrate on comprehending the influence of various contextual factors on the decision outcome. Although the effect of the default option seemed to be stable even under the contextual influences, more research is needed to investigate the interplay of contextual factors and decision biases.

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Table 1
Available Parking Lot Options with Price, Walking Distance, and Duration

Option	Price [€]	Walking Distance [m]	Walking Time [min]
Budget	2.50	400	06:40
Medium	3.50	200	03:20
Expensive	4.50	0	00:00

Table 2

Comparing the Original Decision Attitude Scale Questions to Those Translated and Adapted to the Parking Lot Use Case

Original Questions	Translated and Adapted
I had no problem using the information	Ich hatte kein Problem, die angezeigten Informationen zu nutzen
I am comfortable with my decision	Ich fühle mich wohl mit meiner Entscheidung
The information was easy to understand	Die angezeigten Informationen waren leicht zu verstehen
I wish someone else had made the decision for me	
It was difficult to make a choice	Die Entscheidung war kompliziert
I am satisfied with my decision	Ich bin zufrieden mit meiner Entscheidung
My decision is sound	Meine Entscheidung war vernünftig
More information would help	Mehr Informationen wären bei der Entscheidung hilfreich gewesen
My decision is the right one for my situation	Die Entscheidung war richtig in meiner Situation
Consulting someone else would have been useful	Es wäre sinnvoll gewesen, sich bei der Entscheidung beraten zu lassen

Note. The question highlighted in gray was deleted from the original decision attitude scale questionnaire because it was not applicable for a parking lot decision.

Table 3

Differences between the Single-goal and Multiple-goal Studies and Recommender Systems

Factor	Single-goal	Multiple-goal	Change	Groups
Participants	Same		No	
Offered parking lots	Same		No	
Real walking	No	Yes	Yes	Hypothetical Decision
Real money	No	Yes	Yes	
Real purpose of decision	No	Yes	Yes	
Secondary task	None	Driving	Yes	Treatment
Supervised	No	Yes	Yes	Supervised Design
Visualization	Web view	Car view	Yes	User Interface
Interaction	Mouse	Jog-Dial	Yes	
Contextual Factors	None	Real World	Yes	Contextual Influences
Order of shown offers	Random	Random	No	
Recommended offer position	First	First	No	
Recommended offer preselected	Yes	Yes	No	

Table 4

Comparison of Participant Spending Grouped into Consistent, Influenced and Inconsistent in the Single-goal and Multiple-goal Environments

	Single-goal			Multiple-goal		
	Baseline	Default Option	Change	Baseline	Default Option	Change
Consistent	€65.50	€65.50	€0	€52.50	€52.50	€0
Influenced	€23.00	€31.00	€8.00	€23.00	€31.00	€8.00
Inconsistent	€3.50	€2.50	€-1.00	€21.50	€23.50	€2.00
Total	€92.00	€99.00	€7.00	€97.00	€107.00	€10.00
Per Participant	€2.88	€3.09	€0.22	€3.03	€3.34	€0.31

Figure Caption

Figure 1. The visualization shown on the in-vehicle information system in the baseline run, i.e. no parking lot is recommended. Included are the parking lot price (“Preis”) in Euros and the walking distance (“Fußweg”) in meters and minutes.

Figure 2. The visualization shown on the in-vehicle information system when using the default option bias, i.e. the expensive parking lot is recommended in this case. Translation of the recommendation text for the first parking lot option: “Navigation to this parking lot has already been started”.

Figure 3. Decision distribution of participants in the single-goal and multiple-goal environments.

Figure 4. Spending differences in single-goal and multiple-goal environments.

Figure 5. Example for the grouping of participants into the categories consistent, influenced, and inconsistent based on their choices in the baseline and the default option run.

Figure 6. Comparison of the number of participants being consistent, inconsistent, or influenced in the single-goal and multiple-goal environments.

Figure 7. The influence of urgency on the decision of inconsistent participants in the multiple-goal environment.

Figure 8. The influence of willingness to walk on the decision of inconsistent participants in the multiple-goal environment.

Author Biographies

Klaus Goffart received his degree in Computer Science in 2008 from the University of Bonn. Afterwards, he completed a trainee program at MTU Friedrichshafen and since 2012 he is a PhD student working for the BMW Group. His research interests include decisions biases, in-car recommendations, and multiple-goal environments.

Michael Schermann is a postdoctoral researcher at Technische Universität München (TUM), Germany. Michael's research contributes to understanding how humans make judgments related to the perceived characteristics and severity of risks. His work has appeared in Journal of Information Technology, ACM Transactions on Computer-Human Interaction, and Business Information Systems & Engineering.

Christopher Kohl received his degree in Computer Science in 2014 from Technische Universität München (TUM). He is a PhD student and research associate at the Chair for Information Systems at TUM. His research interests include highly automated driving, social network analysis, and the influence of social networking sites on the perception of risks.

Jörg Preißinger received his degree in computer science in 2004 and obtained his doctorate in natural science in 2008 at the TUM. Since then he has been working as research engineer and project manager at the BMW Group in the fields of mobility services, Internet of things, and augmented reality.

Prof. Dr. Helmut Krcmar is full professor of Information Systems at Technische Universität München (TUM) since 2002. His research interests include information and knowledge management, service management, innovative information systems in health and electronic government, and, at present, leadership in the Digital Transformation.



Parkplätze



Preis: 3,50€

Fußweg: 200m / 3:20 Min



Preis: 4,50€

Fußweg: 0m / 0 Min



Preis: 2,50€

Fußweg: 400m / 6:40 Min



Parkplätze



Navigation zu diesem Parkplatz bereits gestartet.

Preis: 4,50€

Fußweg: 0m / 0 Min



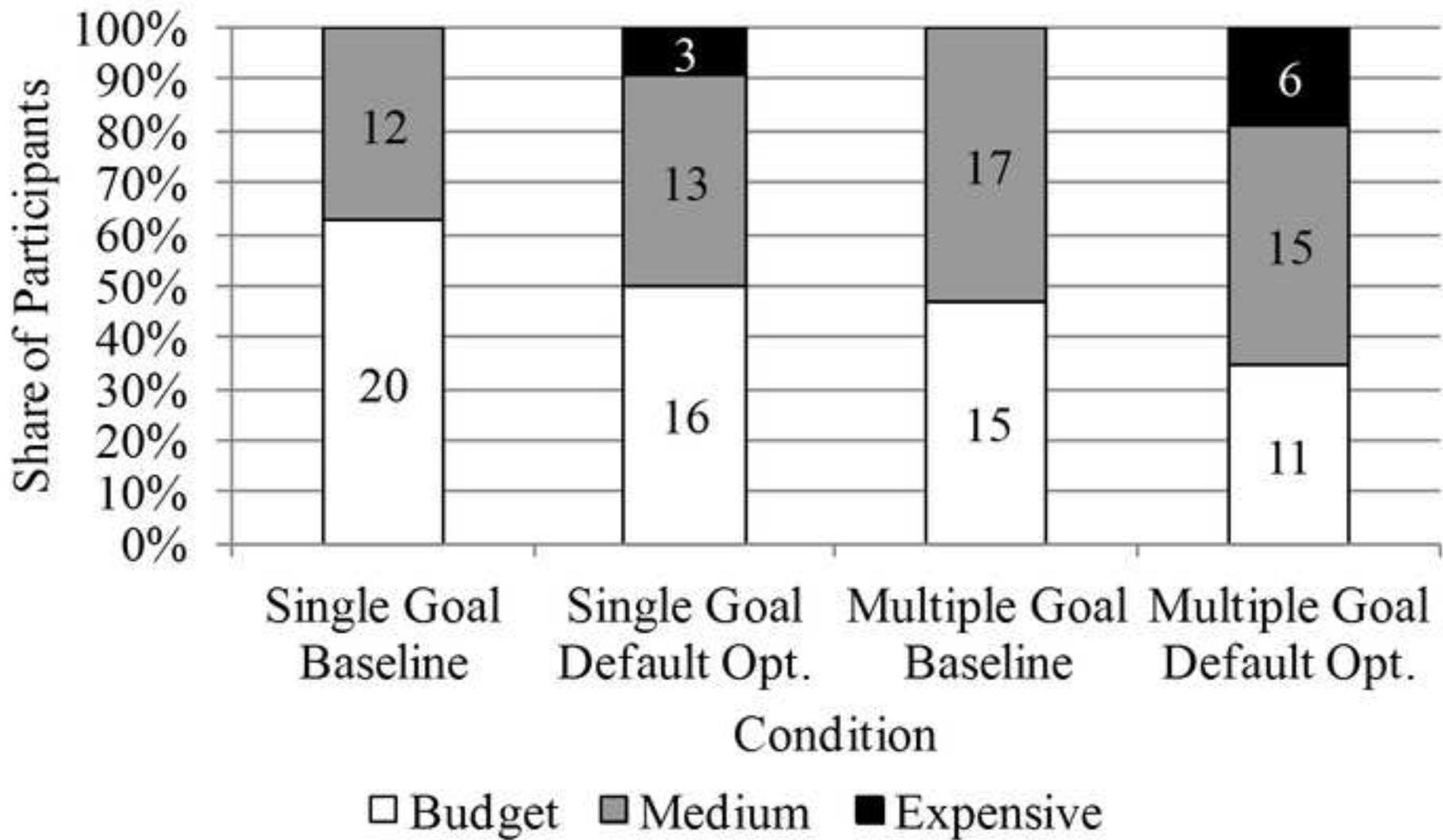
Preis: 2,50€

Fußweg: 400m / 6:40 Min



Preis: 3,50€

Fußweg: 200m / 3:20 Min



		Default Option Bias	
		No	Yes
Environment	Single Goal	€ 2.875	+ € 0.219 → € 3.094 ↓ + € 0.094
	Multiple Goal	€ 3.031	+ € 0.313 → € 3.344 ↓

