

# Means Based Adaptive Persuasive Systems.

**Maurits Kaptein**  
Eindhoven University of  
Technology / Philips  
Research  
Eindhoven, the Netherlands  
maurits@mauritskaptein.com

**Steven Duplinsky**  
Stanford University /  
Accenture Technology  
San Francisco, CA, USA  
steven@duplinsky.com

**Panos Markopoulos**  
Eindhoven University of  
Technology  
Eindhoven, the Netherlands  
p.markopoulos@tue.nl

## ABSTRACT

Large differences in individual responses to persuasive strategies suggest the need for systems that rely on persuasion profiles: estimates of an individual user's susceptibility to different persuasive strategies. Establishing an empirical ground supporting decisions regarding user involvement can provide valuable guidelines for the design of such systems. We describe two studies examining the effects of choice, disclosure, and multiple strategy usage on user compliance to persuasive attempts. We show that involving users in the selection of a specific influence strategy can increase compliance, while disclosing the persuasive intent can reduce compliance. Furthermore, we demonstrate that it is not only feasible, but optimal to choose the single *correct* influence strategy for a given context; even more so than implementing multiple relevant and congruent influence attempts.

## Author Keywords

Persuasive Technology, Influence Strategies, Adaptive Systems, Online Commerce, Recommender Systems

## ACM Classification Keywords

H.5.m Miscellaneous: .

## General Terms

Design, Experimentation.

## INTRODUCTION

Persuasive technologies specifically designed to change user attitudes or behaviors pervade the public domain. Most examples reported in literature focus on creating attitudinal and behavioral changes that are perceived to be socially desirable [18]. Persuasive systems have been successful in influencing users to smoke less [24], lose weight [19], or maintain a healthy workout regime [17]. Applications have even been developed to fulfill more social purposes: improving social interactions [8, 16] and motivating contributions to online communities [3]. Not surprisingly, the use of persuasive

technologies for human wellbeing has been a focus of many researchers and practitioners in the HCI domain [12].

Recent work shows significant individual differences in user's responses to influence attempts [5, 7, 11, 15]. This suggests the relevance of systems that adapt to these differences by utilizing persuasion profiles: estimates of an individual user's susceptibility to different influence strategies [13]. These *adaptive persuasive systems* are distinct from other adaptive systems such as recommender systems because they adapt the *means* of a request to a user (e.g. which influence strategy is used) instead of the *ends*: the suggested goal or user action. In this paper, we empirically investigate the effects of *influence strategy choice*, *the disclosure of usage of such strategies*, and *multi-strategy usage* on users' compliance to persuasive attempts. The results provide guidelines for the design of adaptive persuasive systems.

## Adaptive Persuasive Systems

Adaptive persuasive systems modify their persuasive attempts in response to the behavioral cues of each unique user to increase the system's effectiveness on that individual. There has been some attention in the literature to adaptive persuasive systems, however most of this work focuses on adapting to a changing context or to a specific application domain [1, 2, 24]. Adaptation based on the level of the effectiveness of influence strategies is still uncommon. Because influence strategies can be regarded as *means*, and gained knowledge of an individuals' susceptibility in one domain could potentially be used effectively in other domains, individual specific cross-domain persuasion profiles can be built [13]. These profiles would consist of a description of the estimated effect(s) of a number of persuasive strategies (and the certainty surrounding these estimates) for an individual user.

## Influence Strategies

Human-technology and human-media interactions are remarkably social and often closely mirror the social norms of human-human interactions [22, 25]. As a result, interactive technologies are seen as social actors which "open[s] the door for computers to apply [...] social influence" strategies [10]. That is, not only do humans influence humans, but interactive technologies are designed to, and do, influence human behavior by employing the very same social influence strategies. The array of influence strategies is vast and not well defined: Cialdini [6] elaborates on six strategies at length, Fogg [10] describes 40 strategies, and others have listed over

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100 [26]. However, it is clear that influence strategies can be used as powerful tools to increase the effectiveness of persuasive systems.

Regardless of which list of influence strategies one subscribes to, it is important to note the functional commonality between the majority of influence strategies: to varying extents they all can be deployed irrespective of the attitudinal or behavioral change goals. That is, an influence strategy such as the use of an authority argument [6, 20] can be employed as a *means* to multiple persuasive systems' varying *ends*: A digital workout application gives advice to take an early morning run as recommended by a fitness coach or, likewise, an addiction control application aids users in their attempts to stop smoking by providing targeted advice of a general practitioner. In both cases, a legitimate authority is used to increase compliance to the persuasive technology and thus aid more users in reaching their goal. These are merely examples of two different implementations of how the authority strategy can be effectively implemented in a host of other domains to increase overall compliance; one strategy, many domains.

### Individual Differences

While most influence strategies are effective in increasing compliance or influencing attitudes on a population level, there is theoretical and experimental work indicating sizable differences in individual responses to influence strategies. This work initially focused on individual differences in the overall usage of peripheral cues in the decision process: some people seem more likely to incorporate implementations of influence strategies in their decision process. Next, the work extended to examining differential effects of implementations of specific strategies on individual consumers.

Numerous studies have examined individuals' overall tendency to focus on either central or peripheral processing. Individual differences in Need for Cognition (NfC) [5]—one's tendency to think or elaborate—seem to predict whether or not usage of peripheral cues will influence attitudes. Individuals high in NfC will elaborately scrutinize the arguments presented. On the other hand, for those low in NfC, scrutinizing arguments is less likely and their compliance to requests will be increased by the usage of a persuasive strategy (e.g. the authority strategy). Differences in an individual's overall susceptibility to persuasive strategies as measured by NfC have been shown to have profound behavioral effect on one's susceptibility to individual implementations of persuasive strategies. Individuals scoring high in overall susceptibility to persuasive strategies, as measured using a questionnaire, at a later point in time complied more often to messages that included persuasive strategies, while for those scoring low on susceptibility, the effect was the reverse [14].

Individual differences in responses to implementations of influence strategies do not only exist at a general processing level. There is evidence that there are sizable individual differences in responses to implementations of specific strategies [7]. For example, the *Preference for Consistency* is a measure which identifies up to what level individuals

are influenced by implementations of the consistency strategy. Empirical work shows that specific implementations of this strategy, such as the "Foot-in-the-door" technique, are more likely to be effective for individuals scoring high on this construct [11]. Furthermore, Kaptein et al. [15] show a strong relationship between self reported susceptibility to implementations of the consensus strategy and behavioral responses to requests supported by implementations of this specific strategy. In their study, participants were first asked to rate a number of statements like: "*When I am in a new situation I look at others to see what I should do.*". Participants who highly agreed with this (and similar) statements were more likely, in a seemingly unrelated context, to provide email addresses of personal contacts when the consensus strategies was implemented in the request ("All of the other participants provided several email addresses to us") than participants who did not agree with the initial personality statements.

Based on the aforementioned findings, several authors in the HCI field have proposed the creation of persuasive applications that adapt to individual differences in responses to influence attempts. Fogg [9] was the first to coin the term 'persuasion profile' relating to a description of an individual user's susceptibility to different persuasive strategies. Lacroix et al. [17] described how to efficiently tailor [23] (i.e. adapt to an individual) different persuasive interventions based on an individual user's cognitions. In Study 1, we extend this work by showing how allowing users a small level of choice in which influence strategy they receive creates a leading self report that, through enhanced commitment, increases the effectiveness of the utilization of the user-selected influence strategy. This finding reduces the need to predict the preference for a specific strategy based on previous user behavior or personality measures while broadening the scope of the system's efficacy.

### The Current Paper

It is important to know what the effects of disclosure and user choice are on the effectiveness of influence strategies in persuasive systems. If persuasive technologies indeed start implementing the previously described persuasion profiles, as we believe they will, a series of practical—but important—questions about the implementation of such systems must be answered: Is adaptation actually necessary or would simply using a broad range of non-adaptive influence strategies simultaneously be equally effective? Should the usage of a persuasion profile be disclosed to users to ensure transparency? Should the most effective strategies be disclosed? Should users have a free-choice to inspect, edit, or delete information in their profiles? The answers to these questions are necessary to increase the effectiveness of means based persuasive systems and enable a meaningful discussion of the potential legal and ethical concerns raised by the deployment of such systems. The questions are also directly related to problems of intelligibility and accountability of context aware systems as described by Bel

In this paper, we describe two studies investigating the effects of influence strategy implementations in adaptive per-

suasive technologies. In the first study, we examine whether disclosure of the use of the implemented persuasive strategy or the incorporation of free conscious choice between different strategies influences compliance. In the second study, we determine the effects of simultaneous usage of multiple (both congruent and incongruent) influence strategies. We discuss the implications of this work for designers of persuasive systems by offering a set of guidelines for the design of adaptive persuasive systems. These two studies are, to our knowledge, the first application oriented studies to investigate the effects of trade-offs emerging from the possible implementation of persuasion profiles in the design of adaptive persuasive systems.

## STUDY I: CHOICE AND DISCLOSURE

Study 1 aimed at manipulating a persuasive scenario to examine the effects on compliance of two main factors: *disclosure*, explicitly stating to the user that a influence strategy is being used in an attempt to change their opinion, and *choice*, providing users with a choice between multiple persuasive strategies. Arguably, free choice can be a powerful tool for designers to make persuasive technologies more transparent, move away from a black box approach, and fortify user efficacy by instilling a sense of empowerment through the aforementioned clarity. However, designers must be cognizant of the actual effects of disclosure as it influences user compliance (proven in subsequent findings) and thus has direct implications for the design of persuasive systems and the degree to which designers can incorporate transparency in their design while preserving the systems effectiveness.

In study 1, we used a decision task in which participants were asked to rank a number of items [21]. Participants first ranked the items in the order they believed was most important before they were ostensibly given advice from one of two groups: a group of individuals who previously completed the task successfully (implementing the consensus strategy) or by an expert (implementing the authority strategy). This source of advice was either randomly assigned to the participant (no choice), assigned ostensibly based on knowledge (no choice, knowledge), or chosen freely by the participant (choice). Next, the use of this strategy was either disclosed or not. This results in a  $2 \times 3$  between subject design with three levels of choice and two levels of disclosure.

## Method

### Participants

We recruited participants from a list of university students registered for an introductory research methodology course. The majority of recruited students consisted of undergraduates in both communication and computer science programs. A total of 112 participants were recruited. Fifty three of the recruited participants were female (47.3%) and 59 were male (52.7%). The mean age of participants was 22.2 years ( $SD = 3.3$ ). Participants took part in this study for course credit. All participants were notified prior to the study that participation was not required to receive full credit. If they did participate, they were informed that they could stop at any time and retain all credits. All participants fully completed the experiment.

### Procedure

The study was conducted entirely online. Participants received a link to the online study in their mailbox and were asked to complete the study which would take approximately 30 minutes to complete. After clicking the study link, participants arrived at the study website where they were first introduced to the study and read the consent waiver.

The first task of the study was an item-ranking task in which participants were asked to rank 12 items in order of their importance for survival in the arctic. Participants were introduced to the scenario in the following way:

*You have just survived the crash of a small plane. Both the pilot and co-pilot were killed in the crash. It is mid-January, and you are in Northern Canada. The daily temperature is 25 below zero, and the night time temperature is 40 below zero. There is snow on the ground, and the countryside is wooded with several creeks criss-crossing the area. The nearest town is 20 miles away. You are dressed in city clothes appropriate for a business meeting. You manage to salvage twelve items that you can use to try to survive.*

After the introduction, participants were shown the following list of items and given the opportunity to rank the items from 1 (most important to survival) to 12 (least important to survival):

1. A 20' x 20' piece of heavy-duty canvas
2. A cigarette lighter
3. A compass
4. Dehydrated milk (8 pounds)
5. Duct tape (25' roll)
6. An extra shirt and pair of pants for each survivor
7. A hand ax
8. Iodine water purification tablets (50 tablets)
9. A loaded .45-caliber pistol
10. A loud signal whistle
11. One box of matches
12. A sectional air map made of plastic

After ranking the items participants were told—after an ostensible 6 seconds analysis of their ranking—that “...*some of your rankings were correct, but some could use improvement. You will now get the chance to revise your answers.*”

Participants then saw a screen which stated that they would have the opportunity to revise their answers either based on: “The advice of successful students” or “the advice of an arctic expert”. Both sources of advice were presented with a picture of the respective source. These descriptions of the two sources of advice were pre-tested with 145 subjects to determine overall strategy preference in this survival scenario context. In 144 of the 145 cases, our pilot participants—again college students—chose the expert advice. Hence, it was clear that the expert advice is the preferable strategy for this specific task.

Next, one third of our participants were randomly assigned

to receive the message that they would be “*randomly assigned to one of the two sources of advice*”. In reality, everyone was assigned to receive the expert advice—the preferred advice as based on the pre-test. Another third of our participants received a message that they were assigned to receive the expert advice because “*...this is the advice you will like best*”. The ostensible analysis of participants rankings, which was shown to all participants, was implemented to increase the realism of this condition. The final third of our participants had the option to select the advice they would prefer most; these participants had a free-choice between the two strategies. Consistent with our pre-test results, all of the participants in this condition ended up choosing the expert advice. Hence, the only difference between the three groups was the perception of free-choice, or the basis of this choice if made by the system, before receiving the advice.

After the choice manipulation, participants received short feedback about 6 of their 12 ranked items. For each participant, irrespective of their ranking, it was suggested to: move their most important item (ranked 1) down to rank 7, move the item ranked at 3 to 5, move 5 to 12, 7 to 1, 10 to 3, and 12 to 10. These suggestions were presented one by one, and, during the presentation of these suggestions, the disclosure conditions were implemented. Half of the participants received the message “You ranked [the item] at number [ranking by the participant]. The expert ranked [the item] as [more/less] important at number: [suggested rank].” The other half of the participants were shown the same advice and a message box with the following message: “Please note that research shows that people tend to be persuaded by experts”.

After reading each of the six recommendations, participants were shown a screen displaying their initial ranking of the twelve items compared side by side with the ranking of the expert. Participants could then re-rank their items as desired based on the expert’s advice. For participants in the disclosure condition, the aforementioned message box was again displayed. After re-ranking the items, participants were asked to evaluate the advice that was given. The study ended with a short set of demographic questions about the participant followed by a screen that stated: “The study has ended. You are free to go now with full compensation. However, it is known that people get better at ranking tasks by practicing more often. Would you like to try again?”. If participants chose “no” the study ended. Participants who selected “yes” were given another opportunity to try a *different* ranking task.

### Measures

As a primary measure of the effectiveness of the persuasive attempt, (the advice given by the expert) a compliance score was computed. The compliance score is the sum of the number of ranks changed between initial rank and suggested ranks for the items for which a re-rank was suggested. Hence, if the item that was initially ranked at 1 was moved to position 5 (suggested position was 7) in the final rankings, participants received a score of  $(|7 - 1| - |7 - 5|) = 4$ , (the maximal suggested change minus the actual distance between the suggested rank and the final rank) for that item.

The maximum compliance score was  $(6+2+7+6+7+2 =) 28$ . Negative scores could be obtained when items were moved in greater rank-distance to the suggestions than the initial rank, however, this did not occur in the study.

In addition to the actual compliance score, we measured the perceived usefulness of the expert advice and participants confidence in their final ranking. Perceived usefulness was measured using the following 5 ten-point items (Cronbach’s  $\alpha = 0.934$ ):

1. How useful was the advice provided by the expert?
2. How much did you respect the opinion of the expert?
3. Did the advice from the expert change your opinion?
4. How helpful was the advice from the expert for your ranking in the arctic survival task?
5. How satisfied are you with the help from the expert?

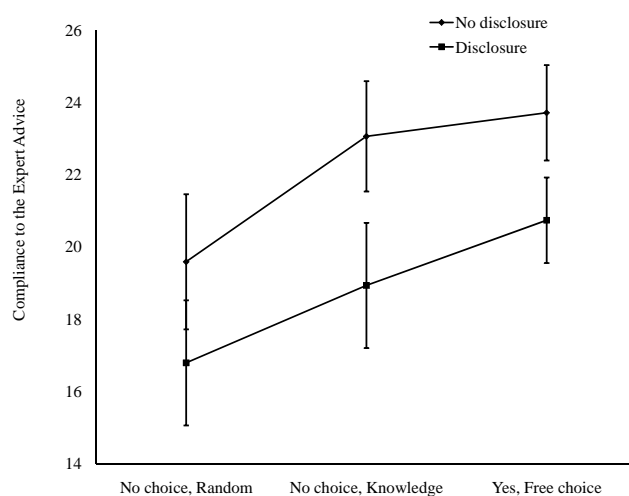
Participants’ confidence in the final ranking was measured using the following 2 ten-point items (Cronbach’s  $\alpha = 0.859$ ):

1. How confident are you in your final ranking?
2. How satisfied are you with your final ranking?

## Results

### Compliance

To examine the effects of disclosure and choice on compliance, a compliance score was computed for each participant and these scores were analyzed using a  $2 \times 3$  between-participants ANOVA. There was a significant main effect of choice,  $M_{no,random} = 18.2$ ,  $M_{no,knowledge} = 21.0$ ,  $M_{free-choice} = 22.2$ ,  $F(2, 106) = 3.38$ ,  $p = 0.038$ . Furthermore, there was a statistically significant main effect of disclosure on the compliance scores,  $M_{no} = 22.1$ ,  $M_{yes} = 18.8$ ,  $F(1, 106) = 6.55$ ,  $p = 0.012$ . No interaction between choice and disclosure was found,  $F(2, 106) = 0.10$ ,  $p = 0.905$ . Figure 1 shows an overview of the results.



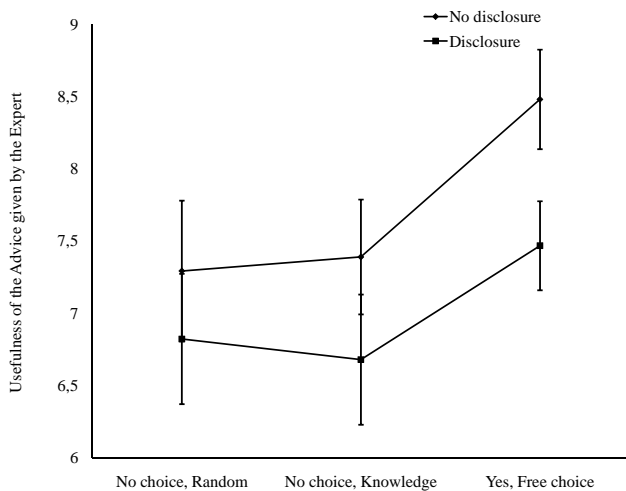
**Figure 1. The effects of choice and disclosure on compliance. Shown are the estimated marginal means and standard errors of the compliance scores. On the x-axis, are the three choice levels, and the two separate lines represent the two disclosure conditions.**

It is clear that compliance to the expert’s advice is higher when the persuasive intent of this implementation was not disclosed. Thus, telling participants about the possible persuasive effect of advice originating from an authority source, diminished its effectiveness.

Using post-hoc tests, the main effect of choice was further examined. The free-choice condition differed significantly from the random-assignment condition,  $p = 0.011$ . None of the other conditions differed significantly from each other. Hence, providing a free choice between the strategies increased participants compliance to the advice given by the expert.

### Usefulness of the Advice

A mean score on the five items addressing the usefulness of the advice was computed for each participant. The usefulness score was analyzed using a  $2 \times 3$  between-participants ANOVA. There was a significant main effect of choice,  $M_{no,random} = 7.1$ ,  $M_{no,knowledge} = 7.0$ ,  $M_{free-choice} = 8.0$ ,  $F(2, 106) = 4.19$ ,  $p = 0.018$ . Furthermore, there was a statistically significant main effect of disclosure on the usefulness scores,  $M_{no} = 7.7$ ,  $M_{yes} = 7.0$ ,  $F(1, 106) = 4.74$ ,  $p = 0.032$ . No interaction between choice and disclosure was found,  $F(2, 106) = 0.24$ ,  $p = 0.787$ . Figure 2 shows an overview of the results.



**Figure 2.** The effects of choice and disclosure on the perceived usefulness of the advice. Shown are the estimated marginal means and standard errors of the usefulness scores.

It is clear that the advice from the expert is perceived as more useful when it is not disclosed to participants the fact that advice from an expert tends to influence opinion. Thus, consistent with the compliance results, disclosure diminishes the perceived usefulness of this implementation of the authority strategy. Furthermore, it is clear that free-choice increases the perceived usefulness of the advice over conditions where participants are not free to choose for this advice source. Using post-hoc tests, it was clear that the free choice condition differed significantly in its perceived usefulness from both the no choice, random condition,  $p = 0.031$ , and the no choice, knowledge condition,  $p = 0, 028$ .

### Confidence

Analysis of the confidence in the final ranking score using a  $2 \times 3$  ANOVA showed a significant main effect of choice,  $M_{no,random} = 6.1$ ,  $M_{no,knowledge} = 6.7$ ,  $M_{free-choice} = 7.7$ ,  $F(2, 106) = 6.20$ ,  $p = 0.003$ . No significant main effect of disclosure,  $F(2, 106) = 3.23$ ,  $p = 0.076$ , and no significant interaction were found,  $F(2, 106) = 1.22$ ,  $p = 0.300$ . Using post-hoc tests, it was clear that the free-choice condition differed significantly from both the no choice, random condition,  $p = 0.001$ , and the no choice, knowledge condition,  $p = 0.031$ . Thus, freely choosing to receive persuasive messages from an authority source increases the confidence that participants have in their final performance on the item ranking task.

### Additional Results

Participants’ willingness to try the task again was influenced by the choice conditions: people in the free-choice condition were more likely to try one more item ranking task at the end of the study,  $\chi^2(2, N = 112) = 4.73$ ,  $p = 0.025$  than those in the other conditions.

### Discussion

The results of study 1 that both choice—the ability to select the persuasive strategy that is used for the specific influence attempts—and disclosure—the revelation of the effect of this strategy—affect compliance. Free-choice led to higher compliance to the request. Disclosure of the fact that the expert advice generally has an influence on others, led to decreased compliance.

Free-choice by users of different persuasive strategies leads to higher compliance, usefulness, and user confidence ratings than system assigned strategies. This implies that designers of adaptive persuasive systems should try to involve users in the selection of different influence strategies. Therefore, an adaptive persuasive system is more effective when its decision to employ a specific strategy is powered (at least partly) by the user of the system. The effectiveness of free-choice is likely a result of the consistency principle: Once people make a certain choice, they will go to great lengths to stick to this choice [6]. Hence, once a user chooses to comply to an expert, they will try to adapt their behavior to be consistent with this choice. The positive effect of free-choice was strong enough to influence significantly more participants in this condition to spend another 10 minutes of their own time in practicing the experimental task to improve their skills after it was made clear that they were free to leave. The results show that obtaining a persuasion profile based on self-report is a potentially worthwhile option to explore in practical system designs.

Disclosing the general effect of the use of the expert strategy reduced its effectiveness. This was probably due to the fact that disclosing the use of a persuasive strategy leads to a higher elaboration state, reduces peripheral processing, and thus lessens the impact of the influence strategy through the peripheral route (see [5]). This finding might imply that secrecy about the use of influence strategies can be beneficial for persuasive systems. If this is true, then an ethical trade

off between the drawbacks of this non-disclosure, and a possible decreased effectiveness of a system which promotes a socially desirable behavior has to be made by the designer. We feel that ways of increasing disclosure and user awareness without a loss of effectiveness should be part of a future research agenda. Positive disclosure methods might benefit from implementing our findings of choice in a way to negate the loss in persuasive effectiveness of disclosure or possibly even increase compliance after further refinement.

## STUDY II: ADDITION AND CONGRUENCY

While Study 1 focused on the effects of both disclosure and choice on the effectiveness of using influence strategies, Study 2 focuses on the applied question whether adaptation is actually necessary: *Is it not just possible to use multiple strategies simultaneously?* While it has already been shown that adaptation at a level of overall susceptibility to persuasive strategies is feasible [15], to our knowledge the effects of using multiple strategies simultaneously has not yet been investigated.

As a first attempt to investigate the effects of the usage of multiple strategies, we investigate the main effect—and thus not the individual differences—of responses to either one or multiple strategies. Furthermore, we test the effects of congruent or incongruent strategies when multiple strategies are presented.

### Method

#### Participants

In Study 2, 44 undergraduates from both communication and computer science programs voluntarily participated. Participants were recruited through an email invitation and received a link to the study website. In total, 136 possible participants were approached, leading to a response rate of 32.4%. Within our final sample 25 (56.8%) of the participants were females. The average age of the participants was 23.8 ( $SD = 7.6$ ). None of the participants in Study 2 had participated in Study 1.

#### Procedure

The procedure of Study 2 was very similar to that in Study 1. Again, participants were asked to take part in an online item ranking study. We used the exact same arctic survival item-ranking task as in Study 1. After reading the consent waiver, participants were first asked to rank the 12 items in their importance for survival. After finalizing their rankings, participants were again told that: *“...some of your rankings were correct, but some could use improvement. You will now get the chance to revise your answers.”*

After the messages, the four conditions were implemented. In Study 2 we focused both on (a) the number of strategies used (*one* or *multiple*) and (b) whether the implementations were congruent (*yes* or *no*).

The number of strategies was implemented as follows: In the single strategy condition participants would either receive advice from the expert source *or* the consensus source. Analogous to Study 1, the possible sources were presented

with a picture and a short textual description. Contrary to Study 1, participants were not ostensibly randomly assigned to either source but were only exposed to one of the sources. Participants were thus told: *“You will have the chance to revise your answers based on advice from...”* and then were shown one single description. In the multiple strategy condition participants were told that they would receive advice from both sources; in this case both descriptions and images were presented simultaneously.

The suggestions made by the sources were the same as those in Study 1 with the exception of the multiple strategy conditions. Here, in the *congruent* condition the authority advice was the same as in Study 1, while for the consensus advice the following message was added: *“The group of successful students **agreed** with the expert”* for five out of the six suggestions. For the sixth suggestion from the expert (presented to the participants as the second suggestion), a message stating that the group of students *disagreed* was added to increase realism. In the *incongruent* condition, these two numbers were reversed and thus the students disagreed with the authority source on five out of six suggested changes and only agreed on one suggestion. We selected the authority strategy as the reference since it was clearly the most preferred strategy in the current context, see Study 1.

There are four experimental groups in the experiment:

1. *Single strategy - Authority.* This group received advice from the authority source only.  $N = 10$
2. *Single strategy - Consensus.* This group received advice from the consensus source only.  $N = 12$
3. *Double strategy - Congruent.* This group received advice from the authority source and the consensus source agreed with the advice.  $N = 10$
4. *Double strategy - Incongruent.* This group received advice from the authority source and the consensus source disagreed with the advice.  $N = 12$

### Measures

Participants were randomly assigned to one of the four groups. After re-ranking their items based on the suggested changes, participants filled out the same post task questions as used in Study 1. However, for the multiple strategies condition the items evaluating the usefulness of the suggestions were asked about both the expert advice and the consensus advice. Eventually, Study 2—similar to Study 1—resulted in data on compliance, the usefulness of the advice, and participants' confidence in the final rankings. Similar to Study 1, the experiment ended with the request to try one more item-ranking task on the individuals own time.

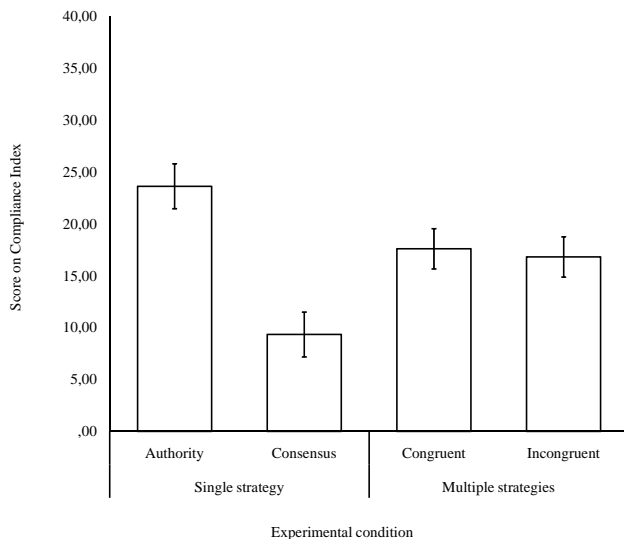
### Results

Since the design of Study 2 does not represent a clean  $2 \times 2$  between-subjects design but presents a partially nested design, the analysis was conducted differently from Study 1. For each of the dependent variables we first looked at a main-effect of the number of strategies. Next, separate analyses were performed to test the effects of the specific strategy that was used, the number of strategies used, and the con-

gruency of the messages under the multiple strategy condition. Finally, a one-way between-subjects analysis of variance with Bonferroni corrected pairwise comparisons was used to compare each of the four experimental conditions to each other.

### Compliance

For the actual compliance to the advice given in the four experimental conditions, we found no significant main-effect of the number of sources: The average compliance score for the single source conditions,  $\bar{X} = 15.8$ ,  $S.E. = 1.96$ , was similar to that of the multiple strategy condition,  $\bar{X} = 17.2$ ,  $S.E. = 1.62$   $t(42) = 0.55$ ,  $p = .582$ . Within the single strategy condition a strong effect—as expected based on the pre-test for Study 1—of the actual strategy that was used was found: Participants in the authority condition,  $\bar{X} = 23.6$ ,  $S.E. = 1.87$ , complied much more to the advice than participants in the consensus condition,  $\bar{X} = 9.3$ ,  $S.E. = 1.61$ ,  $t(20) = 5.80$ ,  $p < .001$ . Within the multiple strategy condition both the incongruent group,  $\bar{X} = 17.6$ ,  $S.E. = 2.34$ , and the congruent group,  $\bar{X} = 16.8$ ,  $S.E. = 2.33$  had approximately similar mean compliance scores,  $t(20) = 0.235$ ,  $p = .816$ .



**Figure 3.** The effects of the use of single or multiple strategies, either authority or consensus and congruent or incongruent on compliance.

Figure 3 shows the means and standard errors for each of the experimental groups. When conducting a one-way four level ANOVA on this data, there is a significant main-effect of condition,  $F(3, 40) = 8.097$ ,  $p < .001$ . Bonferroni corrected pairwise comparisons show that the single strategy consensus condition scores significantly lower than all other conditions, while the single strategy authority condition scores significantly higher. Table 1 shows the mean differences between each of the four conditions, their standard errors, and the  $p$ -value for each possible pairwise comparison. The results indicate that when choosing the optimal single strategy for a specific context, adding other strategies can have a detrimental effect on compliance. It also shows that when the effect of one of the sources is clearly prefer-

able, the effects of incongruence are small.

(A) condition	(B) condition	(A - B)	S.E.	p-value
MS C	SS Cons	8.25	2.79	.005
MS C	MS IC	0.78	2.93	.790
MS C	SS Auth	-6.02	2.93	.046
SS Cons	MS C	-8.25	2.79	.005
SS Cons	MS IC	-7.47	2.93	.015
SS Cons	SS Auth	-14.27	2.93	.001
MS IC	MS C	-0.78	2.93	.790
MS IC	SS Cons	7.47	2.93	.015
MS IC	SS Auth	-6.8	3.06	.032
<b>SS Auth</b>	<b>MS C</b>	<b>6.02</b>	<b>2.93</b>	<b>.046</b>
SS Auth	SS Cons	14.27	2.93	.001
SS Auth	MS IC	6.8	3.06	.032

**Table 1.** Post-hoc comparisons of the four experimental conditions in Study 2. SS=Single strategy, MS=Multiple strategies, Auth=Authority, Cons=consensus, C=congruent, IC=incongruent

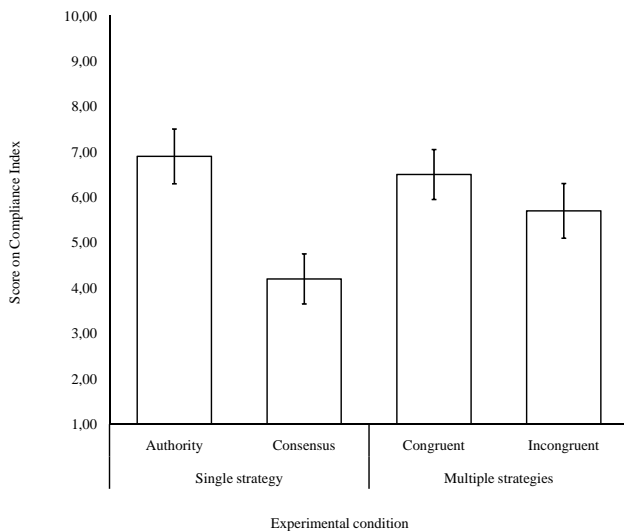
### Usefulness of the Advice

Analysis on the usefulness of the advice was conducted in a similar way as the analysis of the confidence scores. Again, an overall usefulness score was computed (Cronbach's  $\alpha = 0.923$ ). Since participants in the single strategy, consensus source condition only received consensus advice, they evaluated the usefulness of the advice coming from the expert. For all other participants, we analyzed the usefulness of the expert advice.

Similar to the compliance scores for the usefulness of the advice given in the four experimental conditions we found no significant main-effect of the number of sources: The average usefulness score for the single source conditions,  $\bar{X} = 5.5$ ,  $S.E. = 2.44$ , was similar to that of the multiple strategy condition,  $\bar{X} = 6.1$ ,  $S.E. = 1.76$   $t(42) = 1.076$ ,  $p = .288$ . Again, within the single strategy condition a strong effect—as expected based on the pre-test for Study 1—of the actual strategy that was used was found: Participants in the authority condition,  $\bar{X} = 7.0$ ,  $S.E. = 1.85$ , perceived the advice as much more useful than participants in the consensus condition,  $\bar{X} = 4.2$ ,  $S.E. = 2.18$ ,  $t(20) = 3.159$ ,  $p < .01$ . Within the multiple strategy condition both the incongruent group,  $\bar{X} = 5.7$ ,  $S.E. = 1.75$ , and the congruent group,  $\bar{X} = 6.5$ ,  $S.E. = 1.77$  had approximately similar usefulness scores,  $t(20) = 1.032$ ,  $p = .314$ .

Figure 4 shows the mean usefulness scores and standard errors for each of the experimental groups. Post-hoc tests with Bonferroni corrections show that the single use of the consensus strategy scores significantly lower than both the single expert source condition,  $p = .002$  and the congruent multiple source condition  $p = .005$ . However, the pattern is similar to the pattern found on the compliance scores: Choosing the right strategy for the right context makes the advice more useful, and adding irrelevant strategies can decrease the perception of usefulness of the single right strategy.

### Confidence



**Figure 4.** The effects of the use of single or multiple strategies, either authority or consensus and congruent or incongruent on the perceived usefulness of the advice.

Analysis of the confidence scores (Cronbach’s  $\alpha = 0.783$ ) shows that the average confidence score for the single source conditions,  $\bar{X} = 7.7$ ,  $S.E. = 1.89$ , was similar to that of the multiple strategy condition,  $\bar{X} = 8.1$ ,  $S.E. = 1.19$ ,  $t(42) = 0.673$ ,  $p = .504$ . Contrary to the results on compliance and usefulness, within the single strategy condition no significant effect of strategy was found: Participants in the authority condition,  $\bar{X} = 7.8$ ,  $S.E. = 1.65$ , were as confident as participants in the consensus condition,  $\bar{X} = 7.7$ ,  $S.E. = 2.11$ ,  $t(20) = 0.061$ ,  $p < .952$ .

Also, different from the previous results on compliance and usefulness, a significant effect of congruency was found: Within the multiple strategy condition the confidence in the final rating based on advice from incongruent sources,  $\bar{X} = 7.5$ ,  $S.E. = 0.60$ , was lower than that based on advice from congruent sources,  $\bar{X} = 8.8$ ,  $S.E. = 1.35$ ,  $t(20) = 2.992$ ,  $p = .007$ . Hence, while incongruent advice did not lead to lowered compliance, it did lead to a lowered confidence in the final rankings.

## Discussion

Study 2 quantitatively shows human affinity for the preferential strategy, and solely that strategy. Compliance was greatest in the condition where advice came from *only* the preferential source (expert).

Contrary to intuition, having multiple sources of advice agree on the recommendation had not only no positive impact on compliance levels but actually had a slightly negative effect when compared to the preferred strategy (Table 1, bold). This is a fascinating discovery since one would assume two agreeing opinions would be stronger than one. This could potentially be a result of increasing cognition and elaboration with the added advice and the introduction of skepticism or lack of trust with intention of the application (observed in the variance in the usefulness-index across condi-

tions). However, the result is clear that in some situations using multiple strategies can be detrimental as compared to presentation of the single right strategy.

Equally surprising was that there was no appreciable variation between the multiple strategies condition where the sources agreed and the multiple strategies condition where the sources disagreed. This leads us to believe that individuals mentally default to the preferential strategy and thus any disagreement with the preferential strategy has little effect on final attitudes.

It is tempting to assume then that one can simply implement multiple strategies and users will follow the most relevant advice to their cognitive tendencies. While our study showed this to be true, it also showed that the introduction of multiple strategies decreases compliance to the end goal and decreased user confidence in the advice provided by the system. It is thus most desirable to implement the single most effective strategy (or allow users to choose this strategy for themselves as demonstrated in Study 1).

## GENERAL CONCLUSIONS: ADAPTIVITY, DISCLOSURE, AND MULTIPLE STRATEGIES

The use of persuasion profiles is a delicate and complex task from an application design perspective. In this paper, we described two studies that show empirical evidence for the effects of choice, disclosure, and multiple strategies on compliance to persuasive attempts. Since there are large individual differences in responses to the use of persuasive strategies, we expect systems to emerge that rely heavily on persuasion profiles, and thus we feel that providing empirical ground supporting decisions regarding user involvement (free-choice & disclosure) and strategy presentation (single vs. multiple & congruent vs. incongruent) provides valuable guidelines for designers of such systems. We know that these systems are only just beginning to emerge but feel that the results demonstrated in this paper are useful not only for the design of such systems but also serve as input for an ethical debate about adaptive persuasive systems. In this section, we interpret and summarize the findings obtained from both studies and summarize them into three design guidelines. Finally, we conclude by identifying future research opportunities in the field of adaptive persuasive systems.

Study 1 clearly showed that providing individuals with an option about which strategy to choose instead of assigning an influence strategy leads to higher compliance. Thus, designers of adaptive persuasive systems should try to seek user involvement when determining which strategy the system should utilize to accomplish a goal. For example, allowing the user to choose whether they will be linked to their social network to improve their eating habits or whether they will be supported by a general practitioner. Providing users with such a choice leads to increased compliance to requests made by the system and increases the perceived usefulness of the provided advice. The study also showed that the perception of free-choice was enough to increase compliance even though in actuality there was only one acceptable answer as displayed by our overwhelming pre-test re-



sults. Knowledge of the possible influence strategies to use in a given situation, combined with a clear way of presenting these options, can benefit the effectiveness of persuasive systems without the need for complex personal data about the user.

Next to the positive effects of free-choice on compliance and usefulness, a different result also sprang from Study 1: Making the common persuasive effect of the influence strategy that is used explicit, decreased the effectiveness of its use. While this result can easily be explained using the ELM—higher elaboration leads to a decreased effectiveness of the peripheral cue that is used—in the future it might pose an ethical trade-off between the effectiveness of a design and transparency that is maintained toward users. While in general we and others [4] feel that users should be informed about the aims and possible effects of using influence strategies, this mere act might decrease the chances of the design success. However, more research on disclosure of the use of a persuasion profile, privacy perceptions, and their effects on compliance should be carried out to further define the role of disclosure.

Study 2 focused on the question of whether or not multiple influence strategies can be used simultaneously. While it was previously shown that using influence attempts supported by influence strategies can lead to decreased effectiveness for people low in susceptibility to such attempts, it was until now, unclear whether the use of additional strategies would be beneficial, equal, or even detrimental to the effectiveness of a request. Study 2 showed that *only* presenting the right strategy for a given context—in this case using an authority argument—can lead to higher compliance than presenting multiple strategies at the same time. This was even true if both strategies that were used presented congruent messages. Thus, a persuasive system cannot just implement “any trick in the book” and designers should be careful to implement only those influence strategies that increase compliance in a given context or for a given user.

In study 2 congruency—agreement between multiple strategies used—influenced not the actual compliance to the request, but only the confidence people had in their final behavior. We feel that this might partly be due to the overwhelming preference for the authority strategy in the item-ranking context. Thus, for both the congruent and the incongruent conditions participants chose to comply with the expert. The additional congruency only influenced their certainty about their decision. This effect of incongruency on attitude certainty instead of valence is in line with previous findings [27].

To summarize, based on the results presented in this paper we recommend that designers of adaptive persuasive technologies:

1. Involve users in their choice for preferred strategies in a given context.
2. Disclose the implications of the use of influence strategies with caution.

3. Avoid using “redundant” strategies, even if they present a congruent message.

### Final Remarks

The presented studies demonstrate the ability to increase compliance to persuasive systems by *means* based manipulations. Our findings on strategy choice indicate that adaptive persuasive systems might not require complex user personality or behavioral data, but could start by using simple user input. Key choice points cause the user to commit in small increments to the program and become increasingly invested in the advice they receive. The system then not only becomes personal to the user but, in doing so, the user adds increasing amounts of personal commitment to the advice they are receiving; and as we have shown, from the commitment follows compliance and satisfaction.

Further studies should explore different disclosure methods. By further defining exactly what aspects of disclosure reduce compliance, we will be able to more clearly recommend ways to increase transparency without reducing compliance. Furthermore, while in the presented studies we disclosed the possible effect of usage of an authority strategy, it is worthwhile to investigate the effect of user feedback about persuasion profiles directly. Additionally, further studies should be conducted to test the effects of multiple degrees of choice. In other words, if a system had more opportunities for the user to choose or provide feedback, would a relationship be built and thus would compliance increase even further, or would increasing choice points have a null effect similar to implementing multiple persuasive strategies?

We hope that these studies lay the foundation for a move from systems that try to tell a user how to help themselves based on sometimes erroneous analysis of a user profile or previous actions, to systems that facilitate users to aid themselves. As a result of knowledge gained in this paper, we believe that the latter proposed approach provides increased agility and transparency to persuasive systems while not reducing, and possibly even strengthening, its beneficial effect on its users.

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