Is ArguMessage Effective? A Critical Evaluation of the Persuasive Message Generation System

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Abstract. This paper describes an investigation into the effectiveness of ArguMessage, a system that uses argumentation schemes and limited user input to semi-automatically generate persuasive messages encouraging behaviour change that follow specific argumentation patterns. We conducted user studies in the domains of healthy eating and email security to investigate its effectiveness. Our results show that ArguMessage in general supported users in generating messages based on the argumentation schemes. However, there were some issues in particular with copying the example messages, and some system improvements need to be made. Participants were generally satisfied with the messages produced, with the exception of those produced by two schemes ('Argument from memory with goal' and 'Argument from values with goal') which were removed after the first study.

Keywords: Persuasion · Argumentation schemes · Message generation

1 Introduction and Related Work

The process of creating and confirming the validity of persuasive messages is a cumbersome and time consuming task, particularly given the lack of domain independent tools for the purpose of message generation. For example, Thomas et al. [15] manually created and validated healthy-eating messages for each of Cialdini's principles of persuasion[1] using a time-consuming process. They suggested that argumentation schemes could be used to partially automate the process of message creation after message types have been validated, as these schemes have a clear structure that can accommodate modifiable and replaceable variables. This would allow domain experts to easily create messages which

[1] A study was conducted to group messages into the six principles with over 150 participants and the measure used for effective validation of their messages was the Free-Marginal Kappa [13].

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follow a particular argumentation pattern, removing the need for message validation. A corpus of such messages can then be incorporated by, for example, intelligent agent software or used in user studies. There is some existing research that uses persuasive strategies and argumentation together to motivate people to make changes in their behaviour. For example, 'Daphne' [8] and 'Portia' [11] use a conversational agent based on argumentation for behaviour change.

Much existing research illustrates guidelines for persuasive message design and communication, mainly in the domain of health promotion [3,6,9,20] and—to a lesser extent—within the cyber-security domain [2]. Table 1 shows a sample of studies within the health domain with examples of the messages used. Note that the messages produced in these studies were all manually created by the researchers and were not validated before they were used in the evaluation studies. Message creation and validation is a time intensive task depending on the number of messages that are required.

Thomas et al. [15] claimed that automating the process of creating valid persuasive messages could be accomplished by integrating Cialdini's principles of persuasion [4] and argumentation schemes[2] [12,19]. They created a system called ArguMessage [17], built on the basis of the mapped Cialidini's principles and argumentation schemes (see Table 2) intended to make the process of generating persuasive messages easier, and proposed using the system to generate healthy eating messages. Additionally, Thomas et al. proposed to implement the system in the cyber-security domain, focusing on email security and phishing to generate messages to help users protect themselves against malicious emails [14].

In this paper, we evaluate the effectiveness of ArguMessage across these two domains to ensure the results are generalisable. We present two user studies one for each domain, to answer the following research questions:

RQ1. How easy is it to produce messages using ArguMessage?
RQ2. How satisfied are participants with the messages generated?

The goal of this work is to investigate whether ArguMessage is easy enough to use for people who are not experts in argumentation to produce messages, and whether the messages generated by the system are natural enough for users to be satisfied with them.

The remainder of the paper is structured as follows: Sect. 2 describes the studies' design; Sects. 3 and 4 describes the results studies into the generation of healthy eating and email security messages respectively; and Sect. 5 draws conclusions and proposes future work.

[2] Argument schemes are commonly used defeasible patterns of reasoning, for example arguing that something is the case because an expert stated so.

Table 1. Studies that created messages for evaluation with example messages

Reference	Domain	Example messages	Creation	Validated
[1]	Health education messages	People who eat too much fat have more chance of getting cardiovascular diseases If your intake of folic acid is below 8 mg per day, your risk of having a child with a neural tube disorder is 50% higher	Hand crafted	No
[18]	Educational dietary messages	People who do eat enough F & V often have an adequate intake of dietary fibres and therefore more chance of healthy bowels People who eat too much fat have more chance of staying unfit or feeling less energetic	Hand crafted	No
[5]	Health messages	Suntanning helps to maintain vitamin D levels, but causes skin cancer Suntanning gives you an attractive tanned skin, but causes wrinkles	Hand crafted	No
[7]	Dietary habits	If you eat at least 5 portions of FV a day. You will be provided with vitamins and mineral salts which perform the fundamental role of protecting the body. If you do not eat at least 5 portions of FV a day. It may trigger diseases such as cancer	Hand crafted	No
[10]	Public health messages	When you're in a hurry, have a quick and healthy breakfast. FV provide nutrients, fiber, and substances like antioxidants that help guard against the threat of disease	Hand crafted	No

Table 2. Cialdini's principles mapping to argumentation schemes [14]

Cialdini's principles	Argumentation schemes
Commitments and consistency	Argument from commitment with goal
	Practical reasoning with goal
	Argument from waste with goal
	Argument from sunk cost with action
	Argument from values with goal
Social proof	Argument from popular opinion with goal
	Argument from popular practice with action
Liking	Practical reasoning with liking
	Practical reasoning with goal and liking
	Argument from position to know with goal and liking
Authority	Argument from expert opinion with goal
	Argument from rules with goal
	Argument from position to know with goal
	Argument from memory with goal

2 Studies' Design

We used ArguMessage to conduct two studies to generate corpora of healthy eating and email security messages. Both studies had the same design.

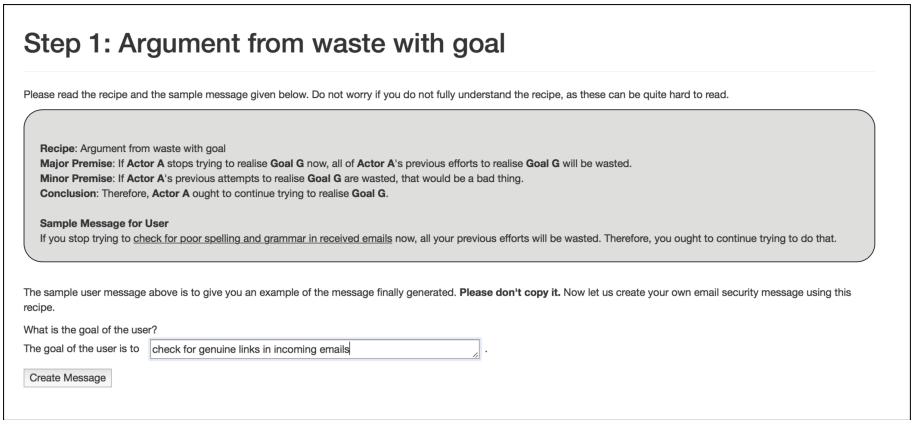

Fig. 1. Explanation of argumentation scheme and questions

Participants were first given instructions explaining what they were required to do, namely generate three persuasive messages using three "recipes" (argumentation schemes); they were then asked to answer some questions to help ArguMessage generate the messages. Next, the description of a "recipe" was shown (including an example of the message it generates) along with a set of questions which the participant needed to answer to generate a message. Once the participant was happy with their answers, ArguMessage used template-based natural language generation to create a message and present it to the participant. Finally, participants indicated their satisfaction level with the message generated on a 5-point Likert scale and provided feedback. This was repeated 3 times, for 3 randomly chosen recipes, leading to the generation of 3 messages per participant. The recipes were based on the 14 argumentation schemes shown in Table 2 (with 9 schemes used in the second study as explained below).

Table 3. Healthy eating domain: mean user satisfaction rating of generated messages within argumentation schemes and p-values for Z-test comparing the mean to 3, and for those not-significantly above 3, to 2

Argumentation scheme	Rating (1–5)	>3	>2
Argument from expert opinion with goal	4.15	***	
Argument from position to know with goal and liking	4.07	***	
Argument from popular opinion with goal	4.06	***	
Argument from position to know with goal	4.00	***	
Argument from sunk cost with action	4.00		***
Practical reasoning with goal and liking	3.93	*	
Practical reasoning with liking	3.89	*	
Practical reasoning with goal	3.84	**	
Argument from popular practice with action	3.63	*	
Argument from commitment with goal	3.42		***
Argument from waste with goal	3.20		***
Argument from rules with goal	3.16		***
Argument from memory with goal	2.57		
Argument from values with goal	2.23		

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

After the first study, the system was improved (see below). An illustration of the completed participant input is shown in Fig. 1. In this instance, the message generated would be "If you stop trying to check for genuine links in incoming emails now, all your previous efforts will be wasted. Therefore, you ought to continue trying to do that".

3 Generation of Messages: Healthy Eating Domain

Participants. We conducted a user study using ArguMessage with lay people recruited via Amazon Mechanical Turk who had an acceptance rating of at least 90% and were located in the United States. This yielded 72 participants, of which 31 were males (5 aged 18–25, 19 aged 26–40, 6 aged 41–65 and 1 aged over 65); and 41 were females (2 aged 18–25, 24 aged 26–40, 13 aged 41–65 and 2 aged over 65). Table 4 shows the participants' attitude, behaviour and knowledge in the healthy eating domain. Participants generated a total of 216 messages.

Table 4. Healthy eating domain: participants' attitude, behaviour and knowledge

Attitude	%	Behaviour	%	Knowledge	%
Extremely important	18.1	Everyday	9.7	Extremely knowledgeable	6.9
Considerably important	38.9	Frequently	41.7	Considerably knowledgeable	38.9
Somewhat important	34.7	Sometimes	43.1	Somewhat knowledgeable	44.4
Slightly important	6.9	Rarely	5.6	Slightly knowledgeable	9.7
Not important at all	1.4	Never	0.0	Not knowledgeable at all	0.0

Table 5. Healthy eating domain: rejected messages

Unexpected user interactions	Total
Copied	50
Copied and not followed instructions	13
Not followed instructions	22
Partly out of domain (but correct message)	1
Different domain (but correct message)	19
Different domain and grammar issues	3
Different domain and punctuation issues	4
Different domain and spelling issues	1

Copied messages include messages which were exactly copied or matched closely with the sample messages

Participants' Satisfaction Rating. We calculated the mean of all messages rated under the specific argumentation scheme to determine satisfaction. The highest rated scheme was 'Argument from expert opinion with goal' with a mean

of 4.15 and the lowest rated was 'Argument from values with goal' with a mean of 2.23 (see Table 3). For this analysis, all 216 messages were used. For almost all argumentation schemes, satisfaction with the generated messages was rated significantly above the midpoint of the scale for 8 argumentation schemes (see Table 3), and at the midpoint of the scale for 4 schemes. However, satisfaction was below the midpoint of the scale for 'Argument from memory with goal' and 'Argument from values with goal'. This answers Research Question RQ2, demonstrating that on the whole, users were satisfied with the messages.

Unexpected User Interactions. Out of 216 messages obtained, we rejected 113 (see Table 5) and approved 61. In addition, there were 42 messages that had minor grammatical (10 messages), spelling (3), typing (1), punctuation (16) and multiple (12) mistakes which could be considered for approval[3].

As shown in Table 5, there were three main reasons for rejection. First, some participants produced messages that were clearly not about healthy eating, but for example about physical exercise (noted in the table as 'Different domain'). Second, there were messages where participants had not provided information in the format requested (for example, in Fig. 1, the participant is asked to complete the phrase 'the goal of the user is to', and a participant may have written a full message instead of completing the phrase (this is noted in the table as 'Not followed instructions'). Third, there were messages that were identical to the sample messages provided with the scheme (noted in the table as 'Copied' if they followed instructions, and 'Copied and not followed instructions' if for example they copied parts of the sample message as answers for the wrong question).

Table 6 shows the distribution of the number of messages produced with the 14 argumentation schemes used in the system. The 'total approved' is calculated by combining the 'approved' and 'considered to be approved' messages. The table does not include all rejected messages, as most were copied or different domain (so, unrelated to a difficulty with using a particular argumentation scheme, but rather to the instructions for the system as a whole), however the number of cases where instructions were not followed may point towards a difficulty with a particular scheme. Overall, the proportion of messages for which people managed to follow the instructions of the argumentation schemes was 84% (86% if excluding copied messages). The proportion was worst for 'Argument from memory with goal', where it was 76%. This answers Research Question RQ1: the system was quite easy to use, but the experimental setup was not clear enough with some participants copying the example message or producing messages which were not about healthy eating.

[3] These were approved after post-processing, and the system changed (as explained below) to do this automatically in future.

Table 6. Healthy eating domain: distribution of messages within the schemes

Argumentation schemes	Total	Instructions not followed	Approved	Considered to be approved	Total approved
Arg. from sunk cost with action	6	0	2	1	3
Practical reasoning with liking	9	2	2	2	4
Arg. from expert opinion with goal	13	1	3	4	7
Arg. from values with goal	13	2	2	0	2
Arg. from position to know with goal and liking	14	0	4	7	11
Practical reasoning with goal and liking	14	1	5	0	5
Arg. from waste with goal	15	1	4	0	4
Arg. from position to know with goal	17	1	5	1	6
Arg. from popular opinion with goal	18	1	2	9	11
Arg. from commitment with goal	19	2	7	4	11
Arg. from popular practice with action	19	1	3	6	9
Arg. from rules with goal	19	3	7	5	12
Practical reasoning with goal	19	2	11	1	12
Arg. from memory with goal	21	5	4	2	6
Total	216	22	61	42	103

Mitigation to Unexpected User Interactions. The system was modified to pre-process most of the unexpected user interactions. The system was revised by adding functions to remove or avoid most language mistakes[4]. Additionally, a training module was incorporated for participants to practice to get an idea of the working of the system before they proceeded to the actual study; they could try it multiple times. The instruction not to copy the example message was emphasized.

Before running the email security study, we also removed the two lowest rated argumentation schemes, i.e., 'Argument from memory with goal' and 'Argument from values with goal', and the three argumentation schemes that involved liking (i.e., 'Argument from position to know with goal and liking', 'Practical reasoning with goal and liking' and 'Practical reasoning with liking'). The latter was done partially because 'liking' is harder to conceptualize in the email security domain and partially because previous studies suggested that messages based on liking were rated lowest on perceived persuasiveness [15,16].

[4] For example, converting capital letters to lower case, removing additional full-stops, and converting 2nd and 3rd person usage to 1st person usage.

Table 7. Email security domain: mean user satisfaction rating of generated messages within argumentation schemes and p-values for Z-test comparing the mean to 3, and for those not-significantly above 3, to 2

Argumentation scheme	Rating (1–5)	>3	> 2
Argument from position to know with goal	3.80	***	
Argument from rules with goal	3.80	*	
Argument from commitment with goal	3.60	*	
Argument from popular opinion with goal	3.36		**
Argument from popular practice with action	3.33		**
Argument from waste with goal	3.33		**
Practical reasoning with goal	3.33		***
Argument from expert opinion with goal	3.00		*
Argument from sunk cost with action	2.79		*

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

4 Generation of Messages: Email Security Domain

Participants. The study was conducted with participants who have some knowledge or experience with anti-phishing. The link to the study was shared on mailing lists and known contacts. The invitation to take part (without the link) was shared on social media which helped to find domain knowledgeable participants. The study had 40 participants, of which 23 were males (2 aged 18–25, 14 aged 26–40, 5 aged 41–65 and 2 aged over 65), 15 females (1 aged 18–25, 10 aged 26–40 and 4 aged 41–65), and 2 undisclosed. Table 8 shows the participants' attitude, behaviour and knowledge in the email security domain. 106 messages were generated.

Participants' Satisfaction Rating. We calculated the mean of all messages rated under the specific argumentation scheme to determine the satisfaction. The highest rated schemes were 'Argument from position to know with goal' and 'Argument from rules with goal' with a mean of 3.80, and the lowest rated 'Argument from sunk cost with action' with a mean of 2.79 (see Table 7). For this analysis, all 106 messages were used. Satisfaction ratings for the messages produced by the different schemes are not similar between the two studies, and seem a bit lower in this study. This is likely an impact of the domain. However, for all argumentation schemes, satisfaction with the generated messages was still rated significantly above the midpoint of the scale for 3 argumentation schemes (see Table 7), and at the midpoint of the scale for 6 schemes. This answers Research Question RQ2.

Table 8. Email security domain: participants' attitude, behaviour and knowledge

Attitude	%	Behaviour	%	Knowledge	%
Extremely important	57.5	Everyday	15.0	Extremely knowledgeable	25.0
Considerably important	35.0	Frequently	32.5	Considerably knowledgeable	47.5
Somewhat important	5.0	Sometimes	32.5	Somewhat knowledgeable	20.0
Slightly important	0.0	Rarely	15.0	Slightly knowledgeable	7.5
Not important at all	2.5	Never	5.0	Not knowledgeable at all	0.0

Table 9. Email security domain: rejected messages

Unexpected user interactions	Total
Copied	24
Copied and not followed instructions	3
Partly out of domain (but correct message)	4
Different domain (but correct message)	8
Not followed instructions	8

Copied messages include messages which were exactly copied or matched closely with the sample messages

Table 10. Email security domain: distribution of messages within the schemes

Argumentation schemes	Total	Instructions not followed	Approved	Considered to be approved	Total approved
Arg. from sunk cost with action	14	1	4	0	4
Arg. from expert opinion with goal	10	1	3	3	6
Arg. from waste with goal	12	1	2	3	5
Arg. from position to know with goal	10	1	4	1	5
Arg. from popular opinion with goal	11	0	7	0	7
Arg. from commitment with goal	15	0	9	3	12
Arg. from popular practice with action	9	0	7	0	7
Arg. from rules with goal	10	2	3	1	4
Practical reasoning with goal	15	2	7	1	8
Total	106	8	46	12	58

Unexpected User Interactions. Out of 106 messages obtained, we rejected 47 (see Table 9) and approved 46. In addition, there were 12 messages with minor grammar (9 messages) and spelling (3) mistakes which could be considered for approval. These mistakes may be fixed by including further post-processing into the system. Table 10 shows the distribution of the number of messages produced with the 9 argumentation schemes used in the system. As before, the 'total approved' is calculated by combining the 'approved' and 'considered to be approved' messages.

Overall, the proportion of messages for which people managed to follow the instructions of the system was 90%. This answers Research Question RQ1: the system was quite easy to use. The changes we had made after the first study had a positive effect on ease of use. Nevertheless, there were still some participants copying the example message or producing messages which were not about email security.

5 Conclusions

This paper investigated the effectiveness of ArguMessage, a system that can semi-automatically generate persuasive messages based on argumentation schemes. We investigated the effectiveness of ArguMessage in two domains: healthy eating and email security. Whilst the studies used lay people, the intention ultimately is for the system to be used by domain experts, to guarantee that the messages produced have domain validity.

We ran the studies with lay people to check that the system is easy enough to use, and does produce messages which are natural enough to satisfy the users. Lay people were used, as domain experts are hard to get, and also would spend considerable time worrying about the correctness of the content of the messages (for example, a dietitian may need substantial time to ensure dietary advice is accurate). This would make studies with experts very time consuming. The studies in this paper ensure that the usability of the system will be good enough for experts to use; if even lay people can produce messages that adhere to an argumentation scheme then so will domain experts.

There were some clear issues when our participants used the system. First, a substantial amount of copying from the sample messages took place. This shows that some participants were not clear enough about what was expected from them. After we added some training and made it more explicit not to copy (by bolding the words) in Study 2, the rate of copying reduced from 29% to 25%, which is still substantial. This indicates that a longer, more detailed training session will be needed (before deploying the system, we could for example add a video tutor). Second, some participants produced messages that were outside of the domain. This is an issue which would not occur with domain experts. Based on the results, we modified the system slightly between the studies, to add some post-processing, and based on the second study we plan to add some more post-processing. Overall, the effectiveness of generating messages was good when considering those participants who produced original messages applicable

to the domain; there were only a limited number of cases were instructions of the scheme were not followed, and there was no scheme that was particularly bad for this. Participants were also generally satisfied with the messages produced, with the exception of two schemes ('Argument from memory with goal' and 'Argument from values with goal') which were removed after Study 1. ArguMessage uses the argumentation schemes that were all adapted from Walton et al. [19]. Given that Walton et al.'s schemes are mainly created for broad purposes, it is plausible for ArguMessage to use domain specific argumentation schemes. So, schemes particularly for healthy eating and cyber-security could be created and integrated [17]. In addition, we are running a study to investigate the extent to which argumentation experts agree that the messages produced match the argumentation schemes. The system is not yet designed to handle all spelling, typing, and other grammatical issues, though we incorporated some post-processing already. Future work would include exploring the possibilities to incorporate full Natural Language Processing to mitigate these issues. ArguMessage is currently only used to generate individual persuasive messages. One could also extend the system to produce messages suitable for a dialogue system.

We only evaluated ArguMessage and were not able to compare it against another system as no other systems currently exist that can semi-automatically generate persuasive messages. A future study could compare the efficiency and effectiveness of using ArguMessage to a manual process of message generation. We also intend to perform a qualitative study with domain experts to get their opinions on the usefulness of ArguMessage and further improvements required, as well as a study where domain experts use ArguMessage to produce messages that will be used in practice.

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