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ABSTRACT

Argumentation schemes are generalised patterns that provide a way to (partially) dissociate the content from the reasoning structure of the argument. On the other hand, Cialdini's principles of persuasion provide a generic model to analyse the persuasive properties of human interaction (e.g., natural language). Establishing the relationship between principles of persuasion and argumentation schemes can contribute to the improvement of the argument-based human-computer interaction paradigm. In this work, we perform a qualitative analysis of the persuasive properties of argumentation schemes. For that purpose, we present a new study conducted on a population of over one hundred participants, where twelve different argumentation schemes are instanced into four different topics of discussion considering both stances (i.e., in favour and against). Participants are asked to relate these argumentation schemes with the perceived Cialdini's principles of persuasion. From the results of our study, it is possible to conclude that some of the most commonly used patterns of reasoning in human communication have an underlying persuasive focus, regardless of how they are instanced in natural language argumentation (i.e., their stance, the domain, or their content).

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

Persuasion, Argumentation Theory, Computational Argumentation, Human-Computer Interaction

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1 INTRODUCTION

A fundamental component of human social interaction is the cognitive ability to reason on the basis of different arguments. Human argumentative reasoning facilitates the exchange of ideas, beliefs, or opinions among others, with the purpose of defending a position and/or convincing or persuading other people. Argumentative reasoning has, therefore, an influence on the capacity for judgement and decision making in human beings.

Over the years, from the field of argumentation theory [37], which encompasses different disciplines including philosophy, linguistics, and psychology, several efforts have been made to study, define, and structure human argumentative reasoning. One of the most prominent reasoning-based structural classifications of arguments is the one proposed under the argumentation scheme concept. Argumentation schemes are common rules or inference patterns that underlie argumentative reasoning and can be articulated and classified providing structure to arguments [40]. Each scheme consists of a set of premises, a conclusion, and a set of connections between the premises and the conclusion mostly considering the underlying logic, which makes them independent of the context and the argumentative domain. More than sixty different argumentation schemes have been proposed and identified in the literature, compiled by D. Walton together with an elaborated meta-classification of such schemes [39, 40]. The thorough research carried out in this direction has enabled computational and Artificial Intelligence (AI) researchers to have a much more structured reference of arguments and argumentation when designing computational argumentation systems: for argument mining [11, 38]; for decision support [20]; and for automated reasoning [29].

A fundamental aspect when defending a position and/or trying to convince someone, is the power or capacity of persuasion. In the field of psychology, several approaches have been adopted to

identify the generally used human persuasion strategies. In this sense, R. B. Cialdini [4] provided a theory in which he defined six principles of persuasion: Reciprocity, Authority, Commitment, Liking, Social Proof, and Scarcity. These principles are specific to persuasion, but not to any context nor domain. Furthermore, this solid definition and classification of persuasive strategies provided a richer dimension for computational persuasion researchers in the proposal of new paradigms of human-computer interaction [5, 16, 17, 35].

However, not much attention has been focused on the relationship between the different persuasion strategies and the different patterns of human reasoning from a domain-agnostic viewpoint. Most of the identified argument-based persuasive research is applied to a very specific domain or within a well defined context, which hampers the interpretation and the generalisation of the presented results. Thus, establishing a relationship between argumentation schemes and Cialdini's six principles of persuasion can: (i) improve the actual understanding of the persuasive properties of argumentative reasoning, (ii) provide a domain independent approach for argument-based persuasion, and (iii) support the evolution of new computational argumentation systems by improving the interaction with human users (e.g., through better persuasion). For this purpose, we conduct a qualitative analysis of the persuasive properties of argumentation schemes. Using the formal structures for argumentation schemes proposed by D. Walton, we explore the relationship of twelve of the most commonly used argumentation schemes in human communication to each of the six principles of persuasion of Cialdini through an experiment conducted with one hundred participants. In the experiment, we combined four different topics of discussion along with arguments in favour and against, with the aim of generalising the results to extrapolate them to computational argumentation models.

2 RELATED WORK

Persuasion is a key element in computational argumentation research. The study of the persuasive properties of arguments and their computational representations make possible to have a better understanding of how human users perceive them when used in competitive (e.g., debate tournament), or cooperative (e.g., decision-making assistance) environments. Furthermore, the use of argumentative structures instead of simple messages make possible to deepen the direct interactions between humans and computer systems. Arguments and argumentative reasoning seen from the computational viewpoint provide a solid framework for approaching the process of human reasoning [24], having a more natural human-computer interaction [9], and generating more reliable explanations of decisions made by computer systems [21]. However, the concept of persuasion and its interpretation may differ substantially from one work to another in the area of computational argumentation. For instance, in [14], persuasion is understood as the effectiveness of arguments in reaching a satisfactory agreement during a negotiation. The authors propose a Reinforcement Learning [30] argumentative agent that is trained to find the best argument for each negotiation step based on an internal set of preferences. This way, the most persuasive expected argument is chosen to improve the effectiveness of argumentation.

A different perspective on argumentative persuasion is presented in [36], in which authors analyze the mental engagement, emotions, and persuasive power of the arguments uttered during a debate. In that approach, the persuasive power is represented with the three major persuasive strategies proposed in [23]: Ethos, Pathos and Logos. Each one of this three strategies tries to be persuasive by considering different aspects. Ethos appeals to vocabulary and social positioning, Pathos appeals to emotions, and Logos appeals to logical reason.

In recent years, research conducted in the field of computational argumentation refers to the establishment of metrics to estimate the persuasive power of arguments based on empirical evidence. For example, in [33], the development of a new scale to measure human perception on message/argument persuasion is presented. This scale relies on three major factors which serve as indicators of the perceived persuasiveness: the effectiveness, the quality, and the capability of the message. Authors conducted an experiment with humans in which these three factors were measured on five different messages belonging to the healthy eating domain. In the same way, the work performed in [25], presents a new metric to measure the persuasive power of arguments and reasoning patterns when they are used in a social network domain for privacy concerns. That metric was derived from the results of an experiment in which the impact of intrinsic human characteristics (i.e., personality traits and social interaction) when rating persuasive power was evaluated. Another interesting approach for evaluating the persuasiveness of arguments based on domain concerns under the framework of abstract argumentation is presented in [8]. From the results of that experiment, it is possible to observe that using human user preferences (i.e., ranking) over the domain concerns make possible to improve the persuasiveness of an argumentative system. These findings are integrated into an argumentative chatbot aimed at persuading human users [9]. In that proposal, persuasion is achieved through a combination of user modelling (i.e., beliefs and preferences over concerns), and a dialogue engine in charge of creating the most persuasive dialogue strategy depending on each user model.

A different approach to empirical metrics comes from the Natural Language Processing (NLP) area of research. Based on the textual properties of natural language inputs, researchers model text persuasion as a downstream task to establish the level of persuasiveness of arguments. For example, in [7], the authors present a new corpus for determining the most persuasive argument from a given pair of arguments. A neural network architecture is used to undertake the task of predicting and modelling persuasion from a natural language input. Another interesting approach is the one proposed in [3] that focuses on the analysis of the impact of the style of news editorial arguments on their persuasive power. For that purpose, five different NLP features are used to model style: Linguistic Inquiry and Word Count [19], a lexicon of emotions (i.e, anger, disgust, and fear) and sentiments (i.e,. positive and negative) [13], argumentative discourse units features (i.e., anecdotal, statistical, and testimonial evidence) [2], arguing elements (i.e., assessments, doubt, authority, and emphasis) [28], and text subjectivity (i.e., subjective or objective) [41]. These features are used to train a Support Vector Machine (SVM) [34] over a task aimed at predicting if a message will be persuasive or not. Finally, the

research conducted in [1] presents a combination of user and text modelling. The authors use users' beliefs, interests, and personality traits, along with NLP feature engineering on natural language inputs to predict persuasiveness of arguments and users' resistance to persuasion.

As it can be observed, most of the existing research on computational persuasion and computational argumentation present a quantitative approach to the task. Previous research tries to measure and quantify the persuasiveness of specific arguments when used in specific domains. Thus, these metrics are dependent on the domain or the type of arguments used. Another important thread running through all of the reviewed works is that the definition of an argument does not match between them. In each research work, the argument definition depends on the needs, the available data, and the objectives of the researchers. Thus, there are important differences between the proposed argument instances (e.g., short messages, complete sentences, opinion and evidence, etc.), which makes it difficult to generalise their findings from an argumentative viewpoint. Therefore, it is interesting to have general evaluations and analyses of the persuasive properties of arguments, in order to establish new computational models of argumentation aimed at interacting with human users. This can be achieved through the evaluation of generic reasoning patterns or structures that are used to build arguments regardless of their domain, their content, or their stance. The problem was partially addressed in previous research, where a relation between domain-specific messages and persuasive properties was established [32]. However, the results can not be easily generalised, due to the domain in which the study was conducted, and the specificity of the used messages. In this work, we have focused on deepening in this line of research by providing domain independent and stronger results. A complete analysis of these lines of related work is provided at the end of the following section, after defining the two concepts on which our research relies: the Cialdini's principles of persuasion and the argumentation schemes.

3 BACKGROUND: PRINCIPLES OF PERSUASION AND ARGUMENTATION SCHEMES

In this section, we define two major concepts which are the pillars of our investigation, and that allow to overcome the identified limitations in computational persuasion and argumentation research. First, Cialdini's principles of persuasion are the six fundamental concepts on which persuasive strategies can be developed. Second, Walton's argumentation schemes provide a structured framework for argumentation. Both concepts were proposed regardless of the domain, generalised for the areas of persuasion and argumentation research respectively.

3.1 Cialdini's Principles of Persuasion

Over the years, different approaches have been introduced in the field of psychology to provide a generalisation of human persuasion strategies. One of the most significant contributions adopted in this field is the one provided by R.B. Cialdini [4]. Cialdini defines six principles of persuasion: *Reciprocity*, *Authority*, *Commitment*, *Liking*, *Social Proof*, and *Scarcity*. These principles are specific to persuasion, but not to any domain or argument. Therefore, a qualitative analysis of argumentative persuasion considering these six principles can be relevant to a more generalised understanding of the persuasive properties of arguments.

3.2 Argumentation Schemes

An argument is the expression of an idea or reasoning that attempts to prove, justify or refute a thesis. The general structure of an argument is composed of a premise (or a set of premises) and a conclusion [12]. This structure must allow the conclusion to be derived from the premises. Argument structures are generally constructed using commonly accepted rules or inference patterns. These patterns can be articulated and classified through different general argumentation schemes. Argumentation schemes were proposed as structured representations of arguments depending on their underlying reasoning pattern [6]. Each argumentation scheme consists of a set of premises, a conclusion, a definition of the relationships between the premises and the conclusion, and a set of critical questions. Argumentation schemes allow a general classification of arguments regarding their underlying logic [39]. Moreover, while the definition of an argument can be fuzzy, argumentation schemes have a well-defined structure and allow for good integration into computational argumentation systems. Furthermore, argumentation schemes were defined considering only the underlying logic. Thus, they can be used regardless of the argumentative domain. One of the theorists who conducted a significant contribution on the identification and definition of argumentation schemes was D. Walton [40]. Over the years, Walton identified over sixty different argumentation schemes commonly used in human argumentation which have been widely used by the research community to generate computational argumentation models encompassing different fields such as the automatic identification of arguments in natural language text [11, 38] (i.e., Argument Mining), the computational representation of argumentative structures [15, 20], and the automatic evaluation of natural language argumentative sources [29]. Thus, the main tasks belonging to computational argumentation research have benefited from the definition of argumentation scheme structures since they provide a structured framework which makes easier to classify, represent, and evaluate arguments depending on their underlying reasoning pattern.

3.3 Cialdini's Principles and Argumentation Schemes for Computational Persuasion

The two concepts introduced in this section provide: (i) a solid psychology-based theory on the principles governing human persuasion that do not depend on any hand-crafted metric, or a hard to interpret (e.g., black-box-based) estimation; and (ii) well-defined formal structures commonly found in human argumentative reasoning that do not rely on the topic, the content, or the stance of the own argument. Both of them provide the necessary tools to deepen on the understanding of argument-based human persuasion strategies. Not much research aimed at generalising findings on the persuasive properties (i.e., qualitative) of arguments has been identified. But we have been able to find a few preliminary works focused in this direction.

Regarding the Cialdini's principles of persuasion, in [5, 17], the authors conducted a study with human participants in order to understand how personality, gender, and age could be affecting the perception of these six principles when trying to be persuaded in a survey and a text-based game respectively. Similarly, in [16], a complete study is made regarding the effectiveness of the different principles of persuasion when used with humans. However, argumentation was not formally taken into account in none of these studies.

On the other hand, argument persuasion is highly influenced by the underlying reasoning used for the elaboration of arguments. Which means that argumentation schemes may represent an important aspect when studying the persuasive properties of arguments. However, the persuasive aspect of argumentation was not explicitly taken into account when defining the stereotyped patterns of human reasoning on which argumentation schemes rely. Previous research analysed the existing relations between argumentation scheme-based adapted messages and Cialdini's persuasive principles in the healthy eating domain [10, 32]. The authors conducted an experiment with 29 participants to analyse the correlation between argumentation schemes and Cialdini's principles. In that study, modified versions of Walton's argumentation schemes were used to simplify the definition of persuasive messages, and to ease the integration of the persuasive principles (e.g., the argumentation scheme of practical reasoning was adapted to a new version of practical reasoning with liking, integrating the liking principle of persuasion into its formal premises and claim). These findings were integrated into a persuasive computational argumentation system to assist human users eat healthy [31]. However, the study and the experiments were carried out considering a unique domain and adapted versions of the original argumentation schemes, which makes harder to generalise their findings. In the present work, we have based in the related work's proposed methodology (i.e., [32] study) and extended the variety of discussion topics to make our results less domain-dependent. Furthermore, our approach relies on a more formal viewpoint of argumentation schemes, instead of using messages created specifically for our experiments or domains. Considering our approach, the implementation of argument-based persuasive systems and the definition of user-tailored persuasive strategies, would benefit from the qualitative analysis of the persuasive properties of (domain independent) argumentation schemes. This way, it will be possible to generalise the findings, and to create domain-specific arguments from general patterns of human reasoning (i.e., argumentation schemes) with knowledge of their specific persuasive properties.

4 STUDY DESIGN

In this paper, we have created a study to bridge the gap between the areas of persuasion and argumentation theory research. For that purpose, we bring together the two concepts that allow us to do a qualitative and domain-independent analysis: Cialdini's principles of persuasion and argumentation schemes. Thus, we present a new study with the objective of overcoming the previously identified limitations, and to consolidate strong relationships between the argument-based persuasion and the underlying logic of argumentation. The study design was motivated by the search for the answer to four different research questions related to the persuasive properties of argumentation schemes: (**RQ1**) How do argumentation scheme reasoning structures relate to the Cialdini's principles of persuasion?; (**RQ2**) How does the topic in which argumentation schemes are instanced into natural language arguments influence on the human perception of persuasive principles?; (**RQ3**) How does the stance of argumentation schemes instanced into natural language arguments influence on the human perception of persuasive principles?; (**RQ4**) Do gender and/or age have an effect on human perception of persuasive principles in arguments?.

4.1 Measures and Instruments

In our study, we considered twelve different argumentation schemes. The selection of this specific set of schemes was motivated both by previous related work [10] and a thorough analysis conducted by the five authors on the well-known compendium of argumentation schemes proposed by Walton in [40], focusing on those which are most frequently found in human communication. Taking this into consideration, the final set of schemes proposed for the present study are: *Argument from Popular Opinion* (AFPO), *Argument from Popular Practice* (AFPP), *Argument from Position to Know* (AFPK), *Argument from Expert Opinion* (AFEO), *Argument from Commitment* (AFCM), *Argumentation from Values* (AFVL), *Argument from Practical Reasoning* (AFPR), *Argument from Waste* (AFWS), *Argument from Sunk Costs* (AFSC), *Argument from Threat* (AFTH), *Argument from Cause to Effect* (AFCE), and *Argument from Rules* (AFRL) (see [40] for the formal definition of the argumentation schemes included in our study). From our selection of argumentation schemes, we can observe significant differences between the underlying logic used in their definitions. For example, AFPP and AFPO are both built taking socially popular and acceptable aspects as premises. But, if we look at the premises of AFPK and AFEO schemes, we can observe that they rely on someone's (i.e., informed or expert source) viewpoint or opinion. Diversely, the premises of an AFCM depend on a previous commitment of the arguer; AFVL's premises are built upon positive or negative judgement values; AFPR's and AFCE's premises rely on conditional logic that justifies the claim; the premises of AFWS and AFSK schemes are defined from a previously done effort or commitment which can be wasted or inconsistent if the claim is not accepted; AFTH's premises combine conditional logic with a threatening position that influence the claim of the scheme; and finally, the premises of the AFRL scheme mainly depend on a previously established rule which leads to the conclusion of the argument. Furthermore, in order to analyse the persuasive properties of argumentation schemes, the six Cialdini's principles of persuasion (i.e., reciprocity, authority, commitment, liking, social proof, and scarcity) were also included in the design of our study. This way, it was our goal to find any existing relation between the underlying logic of arguments and its persuasive approach.

An important issue when analysing an argumentation scheme instanced into a natural language argument is the independence of its message. It is necessary to establish mechanisms to control the bias produced by the message of the argument. We have identified two types of biases that can be produced when instantiating an argumentation scheme: the bias produced by the content of the message and the bias produced by the topic of the message. To

mitigate such biases, we have decided to use multiple natural language arguments instantiating each argumentation scheme. Thus, to find out the persuasive principles associated with the selected argumentation schemes, we created these arguments considering four different topics of current relevance: (**T1**) *Should COVID-19 Coronavirus vaccination be mandatory?*; (**T2**) *Should euthanasia be legalized?*; (**T3**) *Should you take care of your physical appearance to achieve personal and professional success?*; and (**T4**) *Should you do intermittent fasting to lose weight?*

We selected two more controversial discussion topics (i.e., **T1** and **T2**) where people tend to be more polarised, and two more neutral discussion topics (i.e., **T3** and **T4**). Furthermore, we have created two stances (in favour and against) for each of the twelve natural language arguments, representing the argumentation schemes in our four topics. Therefore, we have generated a total of ninety-six arguments instantiating twelve argumentation schemes to perform our experiment. Note that we have designed the premises and conclusions of each natural language argument according to the original argumentation schemes' structures.

We put together all these concepts in a unique questionnaire aimed at measuring the relation between argumentation schemes and Cialdini's principles of persuasion. For that purpose, our questionnaire was structured into six stages (Figure 1). *Stage 0* was designed for registration, the participants must indicate their identification number in order to be able to keep an individual tracking of all of them and to retrieve their personal features (i.e., age and gender). In *Stage 1*, a description of the subject of the study along with the instructions that the participants had to follow to complete the experiment was provided. In the task description, we provided a brief introduction to argumentation schemes and Cialdini's principles as well as a definition of each principle of persuasion. The remaining four stages were the core part of our questionnaire, where a total amount of a hundred and two questions were distributed along our four different topics (one topic per stage). From the total number of items, our questionnaire was composed of ninety-six questions regarding our twelve argumentation schemes in favour and against each topic (i.e., twenty-four per topic), and six attention check questions (created following the guidelines of the online recruitment platform) randomly distributed along the stages of the study. The questions were distributed as follows: *Stage 2* consisted of twenty-four questions related to the topic **T1** along with two attention check questions; *Stage 3* included twenty-four questions related to the topic **T2** together with one attention check question; *Stage 4* contained twenty-four questions related to the topic **T3** along with two attention check questions; and *Stage 5* consisted of twenty-four questions related to the topic **T4** together with one attention check question.

To validate our findings, we used the *Free-Marginal Multirater Kappa* (K_{free}) inter-annotator agreement score [22]. With this metric, it is possible to understand how strongly are perceived the relations between the argumentation schemes and the principles of persuasion, by means of the observed agreement between the participants of our study. Furthermore, the K_{free} was originally proposed as an improved agreement score for statistical studies similar to the one conducted in our research [32], with measurements done in the nominal scale (i.e., principles of persuasion) and more than two different "annotators" (i.e., participants).

Finally, to study the influence of the variables sex and age on the selection of principles of persuasion for each argumentation scheme, we used Pearson's chi-squared statistic (χ^2) [27]. Pearson's chi-squared statistic is a non-parametric test designed to measure differences between groups when using categorical variables. That test can be used both to measure the "goodness of fit" (i.e., the level of disagreement between an observed and a theoretical distribution) and to measure the independence of two variables by the use of contingency tables.

4.2 Context of the Study and Participants

Data was collected through the online platform Prolific [18]. The Prolific platform manages recruitment, payment, and personal information of participants such as age or gender. In addition, it offers several tools to customize experiments, including a set of filters to select the suitable participants for an experiment. If participants successfully complete the experiment they are paid, otherwise they are not paid and they get a penalty that will negatively affect their eligibility for future experiments.

In our experiment we established a filter to recruit participants whose first language was Spanish. Furthermore, we also required our participants to have at least completed fifty Prolific questionnaires, and to have a minimum of a 90% acceptance ratio from past questionnaires in Prolific. The average reward per hour for the participants in the experiment was $8.34.

One hundred and seventeen participants completed the experiment. Seventeen of these participants were excluded for failing one or more attention check questions. The remaining one hundred participants were distributed as 44 women and 56 men ranging in age between 19 and 62 years old ($\mu = 30.9$, $\sigma = 12.0$). The age distribution in the different quartiles were: quartile Q1 = 22.75, quartile Q2 = 26.00, and quartile Q3 = 38.25 years old.

4.3 Procedure

At the beginning of the experiment the instructions were presented to the participants along with an explanation of the purpose of the experiment, a brief introduction to the principles of persuasion, and a description of each of the six principles of persuasion of Cialdini. The description of each persuasion principle of Cialdini showed a short definition with the general idea of the principle and a longer definition that included some examples. Once the instructions of the experiment were shown, the questionnaire was displayed.

In each block the questions were displayed randomly. Each question showed an argument resulting from instantiating one of the twelve argumentation schemes along with seven possible options (see Figure 2).

In each question, participants were asked to classify an argument into one of the six Cialdini principles by selecting one of the six possible options or to select "other" in case the participant considers that the argument does not correspond to any of the six principles of persuasion.

Attention check questions followed the same pattern as the rest of the questions: an argument was shown along with the six options to select the persuasion principle. However, in these questions, the answer that participants had to select was indicated as part of the text of the argument.

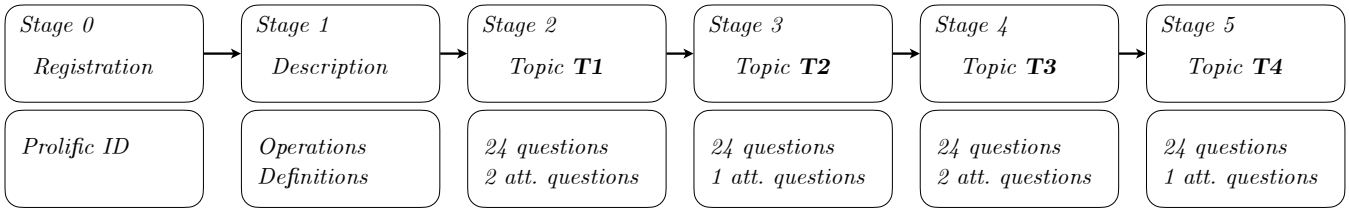

Figure 1: Stages of the experiment. Note that *att.* refers to attention check questions

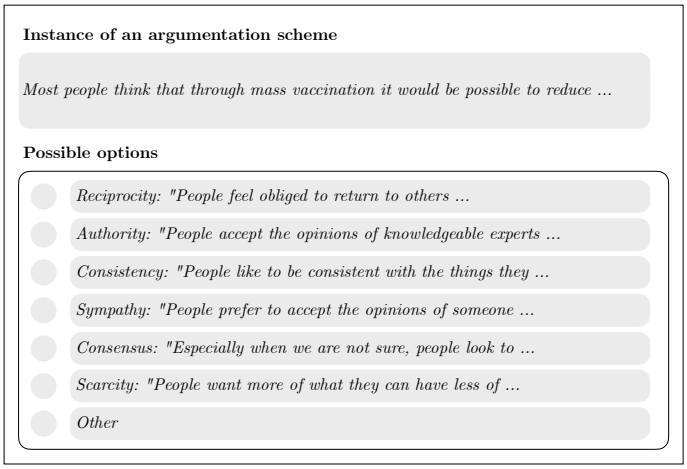

Figure 2: Experiment layout

5 RESULTS

We divided the analysis of the study results into four sections: first, we measured the relation between the twelve argumentation schemes and the six Cialdini's principles of persuasion by means of the K_{free} agreement on the perceived principles by the participants; second, we measure the influence of the four topics (i.e., **T1**, **T2**, **T3** and **T4**) and the two stances (i.e., in favour or against) on the Cialdini's principles selection; third, we analysed the dependency of the gender and the age of our participants on the observed results; and, finally, we analysed the non-related argumentation schemes to better understand the main reasons why no strong agreement is found on the relation between these arguments and the persuasive principles.

5.1 The Principles of Persuasion of Argumentation Schemes

From the results of our study, we have been able to estimate the existing relationships between argumentation schemes and Cialdini's principles of persuasion, as perceived by an heterogeneous set of participants in an heterogeneous set of argumentation domains. Thus, we present a qualitative analysis of the persuasive properties of argumentative reasoning that can be easily generalized to other domains. Our first step for identifying and validating such relations has been to aggregate all the observations and calculate the K_{free} agreement score considering the complete population of our study. The K_{free} metric is interpreted as a reasonable agreement if $0.4 \leq K_{free} \leq 0.7$ and, a strong agreement, if $0.7 < K_{free}$. Therefore, we have only considered a valid relation between an argumentation scheme and a persuasive principle if the agreement is, at least, above the minimum of a reasonable agreement (i.e., $0.4 \leq K_{free}$).

As depicted in Table 1, it has been possible to identify six relationships between argumentation schemes and persuasive principles. In the relations found with a moderate and strong agreement (K_{free} scores highlighted in bold in Table 1), the number of observations captured in our study are mainly concentrated in a unique principle (Cialdini's principles percentages highlighted in bold in Table 1). This analysis indicates us that a specific argumentation scheme is approaching human persuasion considering a specific persuasive principle by its own underlying logic, rather than its domain-related argument instances (i.e., natural language content). Thus, regarding the research question **RQ1**, we observed that AFPO and AFPP are related to the Social Proof Cialdini's principle; AFPK and AFEO are related to the Authority principle of persuasion; and AFCM and AFSC are related to the Commitment principle of persuasion. According to experiment results, the remaining arguments considered in our study do not appear to be related by definition to a specific principle of persuasion.

5.2 The Impact of the Content on the Perceived Principles of Persuasion

To measure the impact of the content of each argumentation scheme on the human perception of the persuasive principles, we performed an analysis similar to the one described in the previous section but considering each topic (i.e., **T1**, **T2**, **T3** and **T4**) independently (**RQ2**). Furthermore, we also analysed how did the stance (i.e., in favour or against) influence our participants' perception in each specific topic (**RQ3**).

While no significant variations have been observed on the agreement scores of the argumentation schemes that were not related to a specific persuasive principle (i.e., AFVL, AFPR, AFWS, AFTH, AFCE, and AFRL), we observed interesting agreement variations on the previously identified relations depending on the topic in which each argumentation scheme was instanced. Table 2 condenses our findings regarding the impact of the content on the perceived persuasive principles in our study. The percentages of the non-related argumentation schemes have not been included in the table since there is not a unique principle monopolising the participants' perceived relation between argumentation schemes and persuasive principles. Topics **T2** and **T4** present the weaker agreement scores on the participants' perception of relations compared to topics **T1**,

Table 1: Relationship between arguments and principles of persuasion. The first columns show the percentage of participants that chose each option for each argument. The last column shows the resulting *Free-Marginal Multirater Kappa* (K_{free}).

Argumentation	Cialdini's principles							
Scheme	Reciprocity	Authority	Commitment	Liking	Social Proof	Scarcity	Other	K_{free}
AFPO	5.375	3.25	4.5	7.5	**75.0**	1.75	2.625	**0.513**
AFPP	4.0	9.0	5.125	11.75	**67.375**	1.125	1.625	**0.444**
AFPK	2.5	**77.75**	2.625	5.875	9.5	0.875	0.875	**0.573**
AFEO	0.5	**88.25**	1.75	5.75	2.75	0.375	0.625	**0.769**
AFCM	9.625	3.0	**70.625**	7.625	4.375	2.0	2.75	**0.477**
AFVL	15.5	4.875	43.5	15.125	6.5	6.75	7.75	0.150
AFPR	21.125	8.0	19.625	20.875	10.75	6.125	13.5	0.087
AFWS	23.875	5.625	21.75	14.0	7.75	22.75	4.25	0.112
AFSC	5.75	2.25	**75.5**	7.5	4.25	3.5	1.25	**0.535**
AFTH	32.625	7.875	8.5	13.75	20.25	10.375	6.625	0.131
AFCE	15.25	5.875	20.75	15.625	14.75	14.875	12.875	0.116
AFRL	6.75	44.125	20.625	4.75	13.75	4.125	5.875	0.192

and **T3** which has the most solid K_{free} agreement (K_{free} moderate and strong agreements are highlighted in bold). Furthermore, if we look at the stance, it is possible to observe two different situations. First, there is the case where the percentages of the participants' selections are balanced regardless of the stance. For example, in our first topic **T1**, AFEO were related to the Cialdini's principle of Authority a 96% of the times for the arguments in favour, and a 90% of the times for the arguments against. Similarly, in our second topic **T2**, the agreement for AFPP related with the Social Proof principle experienced a significant decrease, but the percentages between both stances were still balanced with a 66% for the in favour argument version and a 55% for the against version of the argument. In these situations, it is not possible to conclude that the stance is having any relevant impact on the perception of persuasive principles, but we can infer that the content of the argument regarding each topic is the main cause of these variations. Second, there is the case where the variations of the K_{free} agreement score within a specific topic is associated with a huge drop in a unique stance of the argument instance. For instance, in our fourth topic **T4**, it is possible to observe a decrease of the agreement on the relation between AFPP and the Social Proof principle, perceived only by a 31% of the participants for the argument in favour, but by the 73% of the participants for its version against. Likewise, in the **T2** topic, the perceived relation between AFCM and the persuasive principle of Commitment shows an important decrease of the K_{free} agreement, where only a 34% of the participants selected this principle for the argument in favour. These situations represent a strong evidence of the influence of the stance on the human perception of persuasive properties of arguments. Therefore, from the analysis of the results of our study, it can be concluded that both the topic and the stance of argumentation schemes, instanced into a natural language argument may have a significant influence on the human perception of the persuasive principles related to them.

5.3 The Impact of the Gender and Age on the Perceived Principles of Persuasion

Human intrinsic characteristics, such as gender or age, can also have an influence on the understanding, perception, and the ability to relate argumentation schemes and principles of persuasion. To study the effect of these intrinsic factors on the selection of the principles of persuasion, we performed a comparative statistical analysis using the chi-squared test.

5.3.1 The Impact of the Gender. For gender, we proceed from the experiment sample with a gender distribution of 44 women and 56 men and we analyzed the dependence of the gender variable, with two options (i.e., female and male), and the principle of persuasion variable with seven possible options (i.e., the six principles of persuasion and the option "other"). Considering these two variables, we defined the null hypothesis (h_0) as "gender and principle of persuasion variables are independent" and the alternative hypothesis (h_1) as "gender and principle of persuasion have some degree of dependence".

Table 3 shows the results of the performed chi-squared test (significant results highlighted in bold i.e., $p \leq 0.05$). The theoretical value with a level of risk of 5% and the 6 degrees of freedom (i.e., seven possible answers and two possible genders) for gender and principle of persuasion was $\chi^2_{0.05,6} = 12.592$. Therefore, concerning the research question **RQ4**, with a confidence level of 95% we rejected the null hypothesis h_0, i.e. there seems to be a certain degree of dependence on gender in the selection of the persuasion principle, in argumentation schemes: AFPO, AFPP, AFWS, AFSC, AFTH, and AFRL. For the rest of the argumentation schemes, the null hypothesis h_0 cannot be rejected. Therefore, for those arguments we considered that there is no dependence on gender when selecting the principle of persuasion.

The differences between both genders could also be appreciated in the K_{free} agreement (moderate and strong agreements

Table 2: Relationship between arguments and principles of persuasion disaggregated by topics and stances. For each stance, the selection percentages of participants for each related principle are depicted. For each topic, the *Free-Marginal Multirater Kappa* (K_{free}) is indicated independently.

Argumentation	T1			T2			T3			T4			Cialdini's
Scheme	T1-F	T1-A	K_{free}	T2-F	T2-A	K_{free}	T3-F	T3-A	K_{free}	T4-F	T4-A	K_{free}	Principle
AFPO	79.0	59.0	**0.419**	87.0	81.0	**0.664**	78.0	68.0	**0.478**	80.0	68.0	**0.491**	*Social Proof*
AFPP	76.0	70.0	**0.474**	66.0	55.0	0.300	86.0	82.0	**0.662**	31.0	73.0	0.340	*Social Proof*
AFPK	68.0	51.0	0.294	86.0	83.0	**0.672**	78.0	81.0	**0.596**	91.0	84.0	**0.731**	*Authority*
AFEO	96.0	90.0	**0.844**	95.0	64.0	**0.621**	95.0	95.0	**0.886**	75.0	96.0	**0.725**	*Authority*
AFCM	53.0	81.0	**0.417**	34.0	71.0	0.256	78.0	84.0	**0.611**	78.0	86.0	**0.625**	*Commitment*
AFVL	-	-	0.231	-	-	0.057	-	-	0.252	-	-	0.062	
AFPR	-	-	0.047	-	-	0.041	-	-	0.193	-	-	0.067	
AFWS	-	-	0.120	-	-	0.104	-	-	0.115	-	-	0.109	
AFSC	83.0	83.0	**0.642**	71.0	78.0	**0.495**	85.0	95.0	**0.721**	47.0	68.0	0.281	*Commitment*
AFTH	-	-	0.071	-	-	0.140	-	-	0.159	-	-	0.153	
AFCE	-	-	0.216	-	-	0.070	-	-	0.130	-	-	0.049	
AFRL	-	-	0.363	-	-	0.085	-	-	0.196	-	-	0.124	

Table 3: Results for the Chi-Squared test for the variables principle of persuasion, gender, and sex. And the K_{free} values for the age and gender clusters. The theoretical value for the gender χ^2 test with a level of risk of 5% and six degrees of freedom was $\chi^2_{0.05,6} = 12.592$. For the age χ^2 test, the theoretical value with a level of risk of 5% and eighteen degrees of freedom was $\chi^2_{0.05,18} = 28.869$.

Argumentation	Chi-Squared Test				K_{free} Test						Cialdini's
	Gender		Age		Gender		Age				
Scheme	χ^2 value	p-value	χ^2 value	p-value	Female	Male	*C1*	*C2*	*C3*	*C4*	Principle
AFPO	**15.532**	**0.016**	23.098	0.187	**0.571**	**0.468**	**0.482**	**0.545**	**0.506**	**0.510**	*Social Proof*
AFPP	**17.734**	**0.007**	**45.774**	**0.000**	**0.513**	0.395	**0.452**	**0.474**	**0.468**	**0.405**	*Social Proof*
AFPK	11.205	0.082	22.936	0.193	**0.585**	**0.562**	**0.544**	**0.621**	**0.576**	**0.552**	*Authority*
AFEO	10.711	0.098	**30.066**	**0.037**	**0.816**	**0.732**	**0.756**	**0.847**	**0.741**	**0.752**	*Authority*
AFCM	8.724	0.190	**58.289**	**0.000**	**0.550**	**0.422**	**0.480**	**0.503**	**0.491**	**0.431**	*Commitement*
AFVL	4.563	0.601	**33.042**	**0.016**	0.146	0.155	0.190	0.126	0.098	0.186	-
AFPR	4.12	0.660	**35.674**	**0.008**	0.107	0.067	0.099	0.090	0.086	0.076	-
AFWS	**19.546**	**0.003**	**32.832**	**0.017**	0.135	0.105	0.134	0.105	0.083	0.135	-
AFSC	**22.243**	**0.001**	**36.556**	**0.006**	**0.625**	**0.467**	**0.450**	**0.603**	**0.536**	**0.547**	*Commitement*
AFTH	**14.162**	**0.028**	**42.115**	**0.001**	0.114	0.143	0.156	0.096	0.137	0.139	-
AFCE	5.05	0.537	25.773	0.105	0.110	0.121	0.149	0.081	0.136	0.101	-
AFRL	**20.609**	**0.002**	24.484	0.140	0.182	0.201	0.193	0.191	0.187	0.188	-

highlighted in bold in Table 3). For example, for AFPO, the K_{free} agreement for the female gender group was 0.513 (greater than 0.4) while for the male gender group it was 0.395 (less than 0.4). In addition, it appears that K_{free} agreement was generally higher in the female group than in the male group. Despite these existing differences in the selection of persuasion principles according to gender for some argumentation schemes, in both groups the predominant persuasion principles selected for each argumentation scheme was the same for those argumentation schemes in which the K_{free} agreement was greater than 0.4 (see Table 1).

5.3.2 The Impact of the Age. As described in Section 4.2, the distribution of quartiles for the age variable was: quartile Q1 = 22.75, quartile Q2 = 26.00, and quartile Q3 = 38.25. According to the distribution of these quartiles, we classified the participants into four balanced clusters. We performed a chi-squared test considering the variables age (separated into the four clusters) and persuasion principle. Similarly to the previous case, we set the null hypothesis (h_0) as "age and principle of persuasion variables are independent" and the alternative hypothesis (h_1) as "age and principle of persuasion have some degree of dependence".

For this chi-squared test, the theoretical value with a level of risk of 5% and the 18 degrees of freedom (i.e., seven possible answers and four age clusters) was $\chi^2_{0.05,18} = 28.869$. Thus, regarding the research question **RQ4**, with a confidence level of 95% we can reject the null hypothesis h_0, i.e. there seems to be a certain degree of dependence on age in the selection of the persuasion principle, in argumentation schemes (see Table 3): AFPP, AFEO, AFCM, AFVL, AFPR, AFWS, AFSC, and AFTH. For the remaining four, we

cannot reject the null hypothesis h_0. Therefore, those argumentation schemes did not appear to be age-dependence in selecting the principle of persuasion.

As in the case of gender, in all four age groups, the predominant persuasion principle chosen for each argumentation scheme was the same for those argumentation schemes in which the K_{free} agreement was greater than 0.4 in Table1. In this case, the differences in K_{free} agreement value were not as evident as in the case of gender. Although, we found that the cluster with the highest level of agreement was the *C2* cluster and the lowest agreement was in cluster *C4*, probably because of the dispersion of age in cluster *C4* (i.e., 6.05) was higher than for the other clusters.

5.4 An Analysis of the Non-Related Argumentation Schemes

Finally, we analyse the six argumentation schemes that have not reached a reasonable agreement (i.e., $0.4 \leq K_{free}$) among our participants on the perceived persuasive principle. For that purpose, we will look at the central columns of Table 1, which depict the percentage of the selection of the persuasive principles related to each argumentation scheme in our study. From the set of six argumentation schemes that are not related to a specific principle of persuasion by their underlying logic, we have identified two ruling patterns. Three of these argumentation schemes have a dominant Cialdini's principle of persuasion associated with them, even though no agreement has been observed: in a 43.5% of the selections of our participants the Commitment principle was associated to the AFVL; AFTH have been related to the Reciprocity principle in a 32.6% of the cases; and a 44.1% of the study responses imply an association of the AFRL with the Authority principle. On the other hand, the remaining three argumentation schemes are not dominated by any specific principle of persuasion: AFPR and AFCE have been related to the principles of Reciprocity, Commitment and Liking in the 15-21% of the cases; and AFWS were associated with the Reciprocity, Commitment, and Scarcity principles in the 21-23% of the cases.

Two major conclusions can be drawn from this last section of the analysis of the results. Some argumentation schemes (e.g., AFVL, AFTH, and AFRL) present weak relations with a Cialdini's principle, but the weight of their underlying logic on these relations is not enough compared to other influences such as the content of the natural language argument instances. Other argumentation schemes (e.g., AFPR, AFCE, and AFWS) might not be related to any principle of persuasion by their underlying logic. In these cases, the weight of the persuasiveness of an argument relies almost completely on *external* elements such as their natural language content or stance.

6 DISCUSSION

At the beginning of this work, we emphasised the importance of having a solid knowledge of the persuasive properties of arguments for designing and implementing new approaches on argument-based human-computer interaction. This knowledge makes possible to improve the interactions made by computer systems by being more natural, effective, and user-friendly. However, one of the main limitations identified along the reviewed research on argument persuasiveness is the lack of easy-to-generalise results, and a strong focus on quantitative approaches that are usually constrained by the application domain. Aimed at making a contribution to these identified limitations, we carried out a qualitative analysis of the persuasive properties of argumentation schemes. This way, we research into *how* are arguments trying to persuade human users rather than quantifying their abstract *persuasive power*. For that purpose, we raised four different research questions that have been answered throughout this paper. First, we identified the existing relations between twelve different argumentation schemes and the six principles of human persuasion (**RQ1**), Table 4 summarises this findings. We also carried out an analysis of how did the content of the argumentation scheme (i.e., how the reasoning pattern is instanced with natural language text) influence the perceived persuasive strategy (**RQ2** and **RQ3**). Thus, we found out that the perceived persuasive properties of arguments are quite sensitive to these aspects, and that the process of instancing reasoning patterns with natural language text is a delicate process that must be done correctly in order to keep its properties. Finally, in this work we also analysed how did intrinsic human features (i.e., the gender and the age) influence the perceived persuasive principles of arguments (**RQ4**). Even though we were able to discover that a certain degree of dependence could exist between these features and the human perception of some of the argumentation schemes, there were no significant variations on the principles of persuasion related to these argumentation schemes. However, persuasion is a hard to understand concept, that is not universal, and that may suffer variations from one human user to another. Several features can influence the perceived persuasion of arguments such as the age, the personality, the emotions, or the social context among others. Previous research has explored the impact of features such as the personality, the gender, or the age in message susceptibility [5, 17]. From the results of these studies it is possible to understand which principle of persuasion is more or less effective for different user models composed of the previously mentioned features. These user models can be easily represented by computational argumentation systems (e.g., [26]) that can bring into consideration these findings together with the results of this work to define better strategies and improve their persuasive capabilities.

Previous research in computational persuasion with Cialdini's principles-based messages enable the investigation of a new dimension to the results presented in this work. For instance, in work [32],

Table 4: Argumentation schemes' principles of persuasion. Cialdini's principles with an asterisk (*) indicate weak findings that might be highly influenced by the natural language instance (i.e., topic and/or stance) of the argumentation scheme.

Argumentation Scheme	Cialdini's Principle of Persuasion
AFPK, AFEO	Authority
AFCM, AFSC	Commitment
AFPO, AFPP	Social Proof
AFVL	*Commitment**
AFTH	*Reciprocity**
AFRL	*Authority-Commitment**
AFPR, AFWS, AFCE	None

the authors point out that humans found the Authority principle the most persuasive, and the Liking principle the least in the healthy eating domain. A different study states that the Commitment principle is also strong in this domain [16]. Furthermore, research on argumentation schemes' persuasive power for teenagers in the privacy domain [25] pointed out that AFCQ and AFEO were the most persuasive, while AFPP and AFPO the least persuasive. As we can observe, some of these findings coincide, and make possible to draw stronger conclusions. The aggregation of the findings in previous research with the new results presented in this work make possible to tailor computational argumentation systems to have a better engage in human interaction. For example, with the knowledge of that Authority and Commitment principles performed well in the health domain, it would be interesting to design a system able to interact with human users through AFPK or AFSC. Thus, all these research and empirical results may lead to new formalisations of argument-based computational models for human persuasion.

7 CONCLUSION

In this paper, we present a novel qualitative analysis of the persuasive properties of twelve different argumentation schemes commonly used in human reasoning for its use in computational argumentation models. Throughout the observed results of our study, it has been possible to identify six different relations between arguments' underlying logic and Cialdini's principles of persuasion. Furthermore, instead of presenting specific domain-based results, the way our study and analysis is defined allows us to generalise our findings to any domain, topic or context. This is possible thanks to the qualitative nature of our research, which does not tell us which argument is *more or less* persuasive, but *how* does each reasoning pattern try to persuade in interactions with human users. We also explored how did parameters such as the age, the gender of our participants, the topic, and the stance of the considered arguments can influence the way humans perceive persuasive arguments. All these observations can be of utmost importance for the definition of new argument-based human-computer interactive systems, where humans need to be persuaded (e.g., decision support systems, intelligent assistants, etc.). However, it remains future work to formally integrate the findings of this study into a computational model of argumentation. It will also be an interesting future line of research to deeply explore further human dimensions that may influence the perceived persuasion of arguments such as the mental state, the emotions, or the personality.

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