

Quantifying persuasion: Experimental grounding of attitude change simulations

Ingo Wolf^{1,2*}, Nikolas Zoeller², Tobias Schröder²

¹ Freie Universität Berlin, Berlin, Germany
wolf@institutfutur.de

² University of Applied Sciences, Potsdam, Germany
{wolf, zoeller, schroeder}@fh-potsdam.de

Abstract. This work examines the effects of persuasive communication on attitudes by means of a vignette experiment. We found a linear relationship between (in-)congruence of evaluative judgments between source and receiver and resulting attitude shifts. Moreover, we propose a cognitive model to gain a deeper understanding of how beliefs and emotions cause the observed effects of persuasion attempts.

Keywords: Attitude change, persuasive communication, social influence, emotional coherence, parallel constraint satisfaction

1 Introduction

Many social simulation models of peer influence and resulting collective dynamics of attitudes (typically referred to as opinion dynamics models) are abstract in nature and neglect psychological processes underlying attitude change (e.g., [1]). However, understanding how attitudes are formed and new information is interpreted in light of peoples' pre-existing mental representations, is crucial for understanding phenomena such as ideological polarization of society [2]. A compelling theoretical approach comes from cognitive science, conceptualizing attitudes as parallel-constraint-satisfaction processes, where information integration is driven by maximizing the coherence of current beliefs and emotions [3,4]. Still, experimental evidence on how systematically manipulated (in-)congruence of attitudes in persuasive communication effects attitudes change has remained scarce.

In our work, we seek to contribute to the design of more realistic models of attitude/opinion change by grounding their parameterization in experimental studies, theoretically based on the coherence paradigm in cognitive science. This is work in progress: We report here the results of a psychological experiment designed for such purposes and some first, preliminary simulations of the persuasion process. We consider this groundwork for building future larger-scale models of attitude dynamics at the societal level.

2 Experimental Study

2.1 Methods

Participants and design. Participants (N=480, 47.1% female, age range 18-65 years, $M = 46.63$, $SD = 13.90$) were recruited from a commercial online market research panel in Germany.

We designed a vignette factorial survey [5] to study attitude change through persuasive dyadic communication. The context was a study of attitudes towards novel forms of transportation. Respondents were presented with mock statements about electric and conventional cars and asked to answer a series of questions to assess the influence of these statements on their attitudes towards cars and on perceived characteristics of the statements' sender. The vignettes varied independently along four attributes (i.e., dimensions) including engine type, beliefs about facilitation of psychological goals, emotional tonality, and valence of attitude. A set of 10 vignettes was presented to each respondent, drawn randomly from a pool of 12 vignette sets.

Measures. Before presenting the vignettes, we measured the overall attitude towards conventional and electric cars using mean answers to 13 and 15 believe items, respectively. Each of the 10 vignettes was presented in random order on separate screens followed by six dependent variables. Respondents were asked to indicate their a) level of *agreement*, b) their perceived *attitude shift*, c) the *likability* of the sender, d) the *competence* of the sender, on a six-point Likert scale, and e) the *valence* of the sender and the mentioned car type, on a nine-point semantic differential scale.

2.2 Results

Data were analyzed to determine whether and to what extent the manipulation of valence (positive/ negative) of persuasive messages would cause attitude shifts as predicted by emotional coherence mechanisms. Results are reported separately for conventional cars (CC) and electric cars (EC), due to expected differences in preferences for and in familiarity with these objects (77.9% never used an EC vs. 67.7% use a CC every day). First, we calculated Spearman correlations between respondents' prior attitudes and their (dis-)agreement with differently valenced statements. Congruence in evaluative judgements correlated positively with agreement ($r = .582$ (CC)/ $.669$ (EC), $p < .001$) and negatively when the valence of messages was incongruent with prior attitudes ($r = -.486$ (CC)/ $-.432$, $p < .001$). Second, we estimated separate models for positive and negative messages by ordinary least squares (OLS) regression to quantify effects of persuasion attempts on receiver attitudes (on a transformed scale ranging from -1 to 1). Fig. 1 shows the linear relation between prior attitudes and self-reported attitude changes with significantly stronger effects for positive messages (pos. CC, $F_{1,478} = 50.19$, $p < .001$, $R^2 = .10$; pos. EC, $F_{1,478} = 139.81$, $p < .001$, $R^2 = .23$; neg. CC, $F_{1,478} = 2.59$, n.s., $R^2 = .01$; neg. EC, $F_{1,478} = 11.29$, $p < .001$, $R^2 = .02$). Interestingly, dissimilarities in evaluation triggered negative attitude shifts on the extreme of attitude scales, more pronounced for unfamiliar objects (i.e. EC).

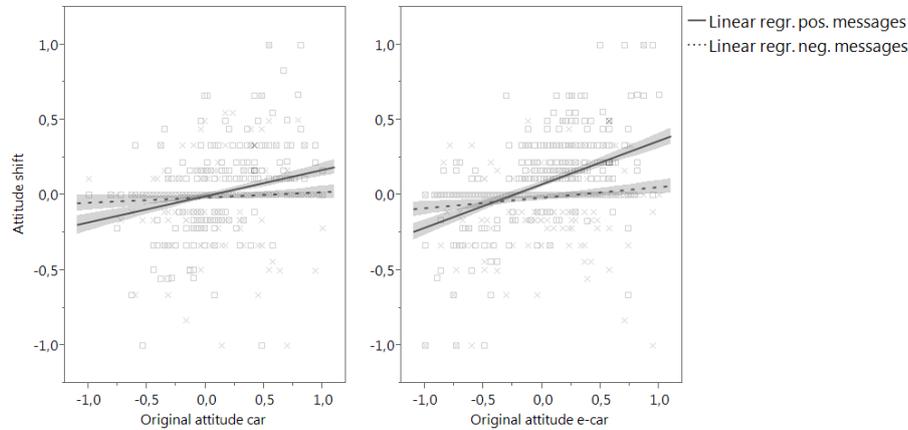


Fig. 1. Effects of positive and negative attitude statements on perceived attitude shift. The scatterplot shows regression including corresponding confidence intervals of attitudes against attitude shift.

3 Simulation Study

We argue that the effects of such attitudinal polarization can be understood at a cognitive level in terms of emotional coherence [3]. Based on HOTCO (for HOT COgnition), an artificial neural network model of emotional coherence proposed by Thagard [3], we developed a computational model of attitude formation. In HOTCO, beliefs and emotions about attitude objects are modeled as a parallel constraint satisfaction (PCS) networks. Goals and actions (i.e., attitude objects) are nodes in this simplified artificial neural network structure. Supportive beliefs are represented as excitatory (e.g., the goal of environmentally responsible behavior is facilitated by the use of an EC), whereas beliefs about contradictory elements (e.g., the use of CC is inconsistent with the goal of environmentally responsible behavior) are modeled as inhibitory bidirectional links between these nodes. Belief strength is represented by link weights that can vary from -1.0 to 1.0. Moreover, HOTCO includes a special valence node reflecting emotional representation associated with different goals. Attitudinal decisions are simulated as iterative spreading of activations across nodes until the network settles at an equilibrium, maximizing emotional coherence between activated and inhibited elements. For mathematical details, see [3].

In a first step, underlying cognitive structures of attitudes towards CC and EC were represented as PCS networks individually for each respondent. The topological structure of networks was identical for all agents, consisting of five goal nodes (i.e., eco-friendliness, comfort, independence, driving experience and good conscience) and two action nodes (i.e., use of CC and EC). Link weights between nodes were parameterized by corresponding empirical belief statements and valence judgments of each participant, assessed during the experiment. To ensure the plausibility of our approach, we regressed self-reported attitudes towards CC and EC on the output parameter of (i.e. activations of attitude nodes CC and EC) of the cognitive model. Indeed, simulation results correspond strongly with the empirical reported attitudes

towards both modes of transport (CC, $F_{1,478} = 1162.69$, $p < .001$, $R^2 = .71$; EC, $F_{1,478} = 1012.38$, $p < .001$, $R^2 = .68$).

In a second step, we modeled the persuasion process of the experimental setting as a communication between two PCS networks - a sending (vignette statement) and a receiving agent (participants). The link weights of agents were parameterized by the specific attributes of the vignettes (sender) and the empirical data (receivers), respectively. We implemented two communication mechanisms: exchange of i) cognitive information (i.e., beliefs), causing a change of receivers' beliefs and potentially a subsequent attitude shift about a specific action and ii) emotional connotations (i.e., valences), changing receivers' emotional connotation of specific goals and potentially leading to an attitude change.

4 Discussion and future work

In this study we found experimental evidence that shifts in attitudes, as a result of persuasive interpersonal communication, are influenced by processes of emotional coherence. The observed changes of attitudes foster the coherence with existing mental representations by distancing from sender's attitude with increased difference in object evaluation. These results are in line with prior research on coherence effects in various decision tasks [6]. To explain the underlying cognitive process of attitude formation and information integration, we analyzed the observed experimental effects with a connectionist model of parallel constraint satisfaction.

Our findings and the proposed cognitive modelling approach contribute to the field of attitude/ opinion dynamics research and demonstrate how existing theoretical models of attitude/ opinion dynamics can be designed both theoretically and empirically in more realistic ways. The next envisioned step will be to implement estimated parameters of peer-to-peer influence and analyze the observed effects of dyadic interaction in a multi-agent version of attitude dynamics (e.g., [7]).

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