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## COGNITIVE SCIENCE & NEUROSCIENCE | RESEARCH ARTICLE

# Approaching the other: Investigation of a descriptive belief revision model

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**Abstract:** When an individual—a hearer—is confronted with an opinion expressed by another individual—a speaker—differing from her only in terms of a degree of belief, how will she react? In trying to answer that question this paper reintroduces and investigates a descriptive belief revision model designed to measure approaches. Parameters of the model are the hearer's *credibility account* of the speaker, the *initial difference* between the hearer's and speaker's degrees of belief, and the hearer's *resistance* to change. Within an interdisciplinary framework, two empirical studies were conducted. A comparison was carried out between empirically recorded revisions and revisions according to the model. Results showed that the theoretical model is highly confirmed. An interesting finding is the measurement of an “unexplainable behaviour” that is not classified either as repulsion or as approach. At a second level of analysis, the model is compared to the Bayesian framework of inference. Structural differences and evidence for optimal descriptive adequacy of the former were highlighted.

**Subjects:** Communication Studies; Philosophy; Psychological Science

**Keywords:** cognitive science; belief revision; epistemology; experimental philosophy

### 1. Introduction

Beliefs are not static. They change over time in light of new information that (might) come up. *Belief revision* is the process of change that takes into account new information. It is a research field that allows normative or/and descriptive approaches. At the normative level, contributions, rich in logical

### ABOUT THE AUTHOR

Spyridon Stelios received his PhD in History and Philosophy of Sciences and Technology from the Department of Philosophy and History of Science at National and Kapodistrian University of Athens (UoA). He lectures at the National Technical University of Athens (NTUA). His main research interests are in the area of epistemology, cognitive psychology and experimental philosophy.

### PUBLIC INTEREST STATEMENT

How would someone react to a different opinion, expressed by another person, about a specific claim? Especially when both opinions are represented by degrees of belief? In trying to answer that question this paper investigates a belief revision model designed to measure and predict the magnitude of this reaction, specifically when it comes to approach. Parameters of the model are the *initial difference* between the individual's and the other's degree of belief, the *credibility* of the other and the individual's *resistance* to change. Two empirical studies were conducted. A comparison was carried out between empirically recorded revisions and revisions according to the model. Results showed that the theoretical model is highly confirmed. At a second level of analysis, the model is compared to Bayesian framework, highlighting structural differences as well as an optimal adequacy of the former.

formalism, extend between philosophy, cognitive science and logic. At the descriptive and empirical level, belief revision is studied mainly in the areas of cognitive and clinical psychology, communication, linguistics, etc.

Respectively, every belief system is more or less “flexible” in relation to the various types of information, especially when we refer to revision of degrees of belief or subjective probabilities. According to some theorists, subjective probabilities do not form an adequate description of the epistemic conditions of humans (e.g. Gilovich, Griffin, & Kahneman, 2002; Kahneman, Slovic, & Tversky, 1982). It is just a normative theory that states how the degrees of belief of a perfectly rational agent *should* behave. And so, degrees of belief do not have to obey the probability calculus. Within the same discourse, formal epistemology models (e.g. Bayesian models) have been criticized for lacking the capability of capturing psychological traits. This critique indicates a further discrepancy between degrees of belief and probabilities. As Thagard (2005, p. 310) notes: “The Bayesian approach is elegant and powerful, but ... it does not have much application to human thinking”.

According to Koutoungos (2003), modeling the dynamics of any belief, within a micro or interpersonal communication context, is only possible when taking into account: (1) a value, or “weight” assigned to another individual (“the other”) acting as the source of information. This value is practically interpreted as the credibility of the source or the credibility attributed to the other—the “speaker”—by the receiver i.e. the “hearer”, and (2) an opposite inner “force”, labeled “resistance” that confines any revision on behalf of the hearer. These two main parameters provide the means of interpreting belief revision and subsequently developing a descriptive measurement model.

This study reintroduces that model as an alternative to Bayesian modeling. Furthermore, this model may help to explain the system responsible for changes in a rational agent’s degrees of belief when a claim is made by another agent. It also aims for a mapping and measuring of these changes. Within this spectrum, this paper examines the promise and drawbacks of it by analyzing its behaviour and its relationship to Bayesian methodology. Secondly the findings of an empirical testing are reported.

## 2. Model configuration

When a person—a hearer—is confronted with another opinion that differs from her’s only in terms of a degree of belief, how will she react? This question triggered a search for a model that could measure and subsequently predict this response. This primary response is investigated in order to measure the change of the degree a proposition  $A$  is believed by the hearer. Particularly, this change is measurable because it complies to the following variables: (1) the *motivation* of the hearer to “register” (or integrate, absorb) the claim  $A$  of the other—the speaker—in her own system of beliefs, where this motive is perceived as a product of two factors: (i) the hearer’s *credibility account* of the speaker ( $W_s$ ) within the broad concept of incorporating all the relative communication details in it, and (ii) the *magnitude of the difference* ( $\Delta_o$ ) between the hearer and the speaker, determined after the announcement of the speaker’s degree of belief to the truth of proposition  $A$ , and (2) the *resistance* ( $K_h$ ) of the hearer’s belief system to change (*anti-motivation*). So, a “bipolar” (*motivation/anti-motivation*) model is put forth with the aforementioned variables.<sup>1</sup>

### 2.1. Anti-motivation

Under revision, belief systems are more or less receptive in relation to the various types of information.<sup>2</sup> They more or less resist against the choice of absorbing a certain amount of information and revising beliefs of a particular subject. So, resistance of the hearer to the necessary changes that have to take place in order for her to absorb, to some extent, presented information is emerging as a parameter of this descriptive model. It refers to the tendency to resist any change in her beliefs, especially after the presentation of an argument in favor of a different level of support for this specific belief.<sup>3</sup> Within this context, resistance depends on how rigid the system of values is. So, the concept is been investigated on how inclined these belief systems are to change. For that it is a multidimensional subject that includes cognitive, behavioural as well as emotional components.

Resistance is expressed by a constant reflecting the recipient’s character and overall psychological status. In other words, resistance is treated as a natural predisposition inscribed in the personality of each individual.

### 2.2. Motivation

Taking the initial difference  $\Delta_0$  between the speaker’s and the hearer’s degrees of belief in a single proposition ( $\Delta_0(A) = |P_h(A) - P_s(A)|$ ) as a measure one component of the hearer’s motivation to revise her degree of belief in that proposition, is “axiomatic”. It reflects a motive for reducing the tension between her and the speaker, in the same way that observed “dissonance” urges its reduction in formal theories of cognitive dissonance (e.g. Festinger, 1957). Thus, the extent of the recorded initial disagreement can naturally function as motivation within this “primary” response. The “conflict” recorded when an evaluated source’s degree of belief is declared, is a sufficient reason to embark upon its reduction as much as two conflicting beliefs in one’s mind is. In this light, the divergence of opinions stands for a potential desire for convergence. This feature alone represents a new aspect to the function of belief revision.

The overall motivation to revise is perceived also as the product of the credibility  $W_s$  of the speaker (according to the hearer) that broadly includes contextual positive communication data (for instance, the recognition or acceptance that the speaker enjoys in her workplace). This value is practically interpreted as the credibility that the receiver of information attaches to the speaker. This is how the full background of the dynamic process of belief revision is achieved. Thus, the third parameter of the model is the credibility of the source, the credibility attributed by the hearer to the speaker.

### 2.3. The balancing equation

The management on behalf of the hearer of the initial difference  $\Delta_0(A)$  implies the possibility of  $\Delta_0(A)$ ’s gradual shift, for the purposes of her approach towards the speaker. An obvious ending to this shift is the balancing of the two opposing tendencies: the resistance ( $K_h$ ) of the hearer to approach the speaker  $s$  by revising sufficiently her set of beliefs, and the composite motive [ $W_s \times \Delta_0(A)$ ] towards speaker. One possible and simple description of this confined approach (and outcome) is represented algebraically by the following equilibrium/equation:

$$[\Delta_0(A) - \Delta P_h(A)] \cdot W_s = K_h \cdot \Delta P_h(A) \quad (W_s \geq 0, K_h \geq 0) \tag{1}$$

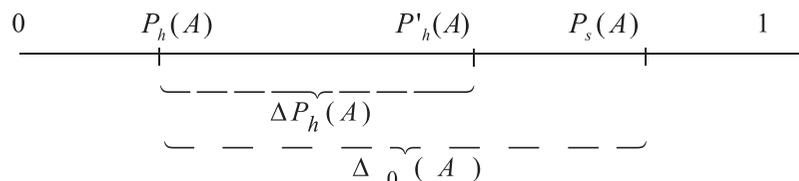
where,  $\Delta P_h(A)$  is the extent of approach, in absolute values, within the spectrum of  $P_h(A)$  and  $P_s(A)$ , subjective degrees of belief that represent the standings of  $h$  and of  $s$  on proposition  $A$ .<sup>4</sup>

Equation (1) is obviously arrived at by identifying  $h$ ’s final approach to  $s$ , (symbolized by  $P'_h(A)$  in Figure 1), when the initially zero-value right part increases so as to equal its parallel decreasing left part. The final approach therefore, given by (1) is:

$$\Delta P_h(A) = \frac{\Delta_0(A) \cdot W_s}{K_h + W_s} \tag{2}$$

Equation (2) is the mathematical expression of the model investigated in this paper. It reflects the incremental shifts of degrees of belief towards an *agreement* between hearer and speaker.

**Figure 1. Graphical representation of a belief adjustment scenario between hearer ( $h$ ) and speaker ( $s$ ).**



### 3. Behaviour of the model

Let us look first how the model's *extreme values* are interpreted. Since the values of all three parameters ( $\Delta_0$ ,  $W_s$ ,  $K_h$ ) are non-negative numbers and  $0 \leq \Delta_0 \leq 1$ ,  $\Delta P_h(A)$  remains firmly within the actual interval  $[0, 1]$ . An interesting case is the "halfway" scenario, where  $W_s = K_h$  and therefore the shift is  $\Delta P_h(A) = \frac{\Delta_0}{2}$ . In addition,  $\Delta P_h(A)$ 's two extreme values are obtained when (1) for  $\Delta P_h(A) = 0$  initial difference  $\Delta_0(A) = 0$  or credibility  $W_s = 0$  (and  $K_h > 0$ ), which is reasonable and (2) for  $\Delta P_h(A) = \Delta_0(A)$ , resistance  $K_h = 0$  and  $W_s > 0$  (i.e. non-zero credibility).

In the case of  $W_s = 0$ , the hearer does not attribute any credibility (weight) to the speaker, entailing that there will be no revision at all, so  $\Delta P_h(A) = 0$ . In the case of  $K_h = 0$ , it follows from the equation that  $\Delta P_h(A) = \Delta P_s(A)$ , i.e. that there is an absolute approach between hearer and speaker. When both  $W_s = K_h = 0$ , then indeterminacy is expected, as we obviously refer to a non-measurable situation. Of course this is a plausible and interesting, especially in psychological terms, scenario. But still it is a case that cannot be processed arithmetically by the model. In that sense one might argue that it also represents a limitation of the model.

The ways the parameters vary in the mathematical relation is consonant with their interpretation. More specifically, according to Equation (2),

$$\Delta P_h(A) = \frac{\Delta_0(A) \cdot W_s}{K_h + W_s} \text{ with all } \Delta_0, W_s, K_h \text{ positive.}$$

Consider  $f(x, y) = a \frac{x}{y+x}$  with all  $a$  (constant),  $x, y$  positive. One has:

$$f_x = \frac{\partial f}{\partial x} = a \frac{y}{(y+x)^2} > 0.$$

So  $f$  is an increasing function of  $x$ . Now:

$$f_{xy} = \frac{\partial^2 f}{\partial y \partial x} = a \frac{x-y}{(y+x)^3} < 0 \Leftrightarrow x < y.$$

Thus the rate of increase of  $f$  with respect to  $x$  is a decreasing function of  $y$  just in case  $x < y$ .

*Conclusion 1:* For given  $\Delta_0$ ,  $\Delta P_h(A)$  increases as the credibility of speaker  $W_s$  increases (and the resistance of hearer  $K_h$  is held fixed), but this increase rate slows down when  $K_h$  is increasing at values greater than  $W_s$ . So, there is a proportional relationship between  $\Delta P_h(A)$  and variable  $W_s$  (for a graphical representation, Appendix 1, Figure 2).

On the other hand,  $f_y = \frac{\partial f}{\partial y} = -a \frac{x}{(y+x)^2} < 0$ . So  $f$  is a decreasing function of  $y$ . And since  $f_{yx} = \frac{\partial^2 f}{\partial x \partial y} = a \frac{x-y}{(y+x)^3} < 0 \Leftrightarrow x < y$ , the rate of decrease of  $f$  with respect to  $y$  is a decreasing function of  $x$  just in case  $x < y$ .

*Conclusion 2:* For given  $\Delta_0$ ,  $\Delta P_h(A)$  decreases as the resistance of hearer  $K_h$  increases (and the credibility of speaker  $W_s$  is held fixed), but this decrease rate slows down when  $W_s$  is increasing at values smaller than  $K_h$ . So, there is an inversely proportional relationship between  $\Delta P_h(A)$  and resistance  $K_h$  (for a graphical representation, Appendix 1, Figure 3).

So, the equation does yield reasonable outcomes. It is firmly moving in values between 0 up to 1 representing the hearer's "available shift space" and satisfying the micro-theoretical requirements of the two opposite and balancing tendencies of revision.

By comparing this belief revision (or adjustment) model<sup>5</sup> to Bayesian updating, one can see a better behaviour of the former as far as its limit values are concerned. For example, when the hearer's initial degree of belief  $P_h(A) = 0$  then  $\Delta P_h(A)$  could be other than zero (for  $P_s(A) > 0$ ,  $W_s > 0$ ,  $K_h \geq 0$ ).

$$\Delta P_h(A) = \frac{\Delta_0(A) \cdot W_s}{K_h + W_s} = |P_h(A) - P_s(A)| \frac{W_s}{K_h + W_s} = P_s(A) \frac{W_s}{K_h + W_s} \neq 0$$

Of course this is not the case with Bayes' rule. According to that rule, a rational agent follows strict *conditionalization* and therefore attributes posterior probability zero to any proposition to which she attributed prior probability zero, regardless of the evidence. Should she make, that is, the mistake to give prior probability zero in a true sentence, she will never be able to recover from this initial mistake, whatever she ascertains empirically. Otherwise, this would be a "dogmatic" mistake that should be avoided.<sup>6</sup>

A Bayesian combines prior beliefs about a proposition with observed empirical evidence in order to form a posterior degree of belief. An indicative representative writing of Bayesian revision rule, in accordance with the existing theoretical framework for every proposition  $A$ , is:

$$\text{Prior} = P_{\text{initial}}(A) = P_h(A), P_h(E) > 0, P'_h(E) = 1, P(A/E) = P'_h(A)$$

Within the current theoretical context, the sentence "The speaker's degree of belief in  $A$  is  $\epsilon$ " represents, for the hearer, evidence  $E$ . The posterior probability of the hearer about  $E$  is

$P'_h(E) = P'_h(\overbrace{P_s(A) = \epsilon}^E) = 1$ , because after the speaker's announcement, the hearer is sure about the announced degree of belief, so she yields posterior probability equal to one. Thus Bayes' rule is formed as follows:

$$P'_h(A) = P_h(A/P_s(A) = \epsilon) = \frac{P_h(P_s(A) = \epsilon/A) \cdot P_h(A)}{P_h(P_s(A) = \epsilon)}$$

In the course of comparing the two models, a question of whether the AK Model follows indeed the probability calculus should be asked. An adequate answer on this cannot be given in this paper. What can be said clearly now is that the model's structure ensures that the hearer's revision is delimited in interval  $[0, 1]$ . In addition, as it will be shown below, the conversion of credibility and resistance empirical scores into percentages provided a more rational probabilistic behaviour. So, there is a primary association with probability theory. But, nevertheless, one must not ignore the fact that subjective probability is a normative theory about how degrees of belief of a rational agent should behave. A Bayesian model developed with subjective probabilities (understood as degrees of belief) bears the limitation that there are psychological findings that show that degrees of belief do not usually agree to probability calculus (e.g. Kahneman et al., 1982). Under the assumption that the AK Model is compatible with the probability calculus and thus subjective probabilities, it could be argued that it takes into consideration psychological factors. The psychological aspect is evident most in resistance whereas credibility is a more externalized but at the same time strictly personalized parameter. Both of them are unsterilized from the specific communication context.

So, I am referring to belief change in circumstances of reliable information, information that could be matched, as already shown, to Bayesian evidence. What differentiates the AK model is that the hearer changes/restates beliefs primarily on the basis of the credibility that she attributes to that information.<sup>7</sup>

As will be shown herein below, this study is in the field of experimental philosophy, where intuitions are of high research interest. So, I believe a reference to the model's relation to intuitions is necessary. In principle, an approach on behalf of the hearer towards the speaker provides a basis to understand initial intuitions about belief systems. These intuitions may refer to the possibility of

revision in degrees, even if only as a primary response. The hearer adjusts her degree of belief immediately, or shortly after any consideration within the context of discourse. The AK model's properties are set also to refer to an almost instant cognitive process on behalf of the hearer. So, intuitions (might) play a role. On a more general framework, Gärdenfors (1988) has proposed *epistemic entrenchment* as a standard form of intuition. Some of our knowledge and beliefs about the world are more important than others. When an individual is forced to choose between two beliefs she will subtract the less entrenched. So, within the process of revision, epistemic entrenchment contributes to deciding what beliefs are maintained by satisfying certain rules of the model.

In our case, it is *resistance*, *initial difference* and *credibility* that define the extent of belief change. In particular, resistance refers to the tendency of the individual to resist any change of her beliefs. It depends on how rigid her belief system is. An important role in this process plays the kind of belief and any relevant information about it. For example, revision of scientific beliefs is not, in most cases, hampered by emotional prejudices (or in that sense resistance), while this is not the case with beliefs concerning ethics or psychology. Therefore, resistance is relevant to specific beliefs represented by specific propositions. Of course, this study offers little knowledge on this, because testing refers to average estimates of resistance and of credibility. Nevertheless, when  $K_h$  tends to zero consensus is reached between speaker and hearer making the kind of proposition crucial for any agreement.

Besides resistance, the credibility parameter is also expected to depend on propositions. The specialization of the speaker in a specific subject affects the hearer's evaluation, consequently specifying the size of her attributed credibility. This means that the kind of propositions influences credibility estimates. It has to be noted that social-psychological ascriptions such as cheating or lying are excluded as possible attitudes of the speaker.

#### 4. Experimental testing

In order for the AK Model (see Equation 2) to be tested, in terms of predictability and empirical adequacy, two studies (pilot-main) were conducted. The main objective was to check in an empirical level whether it predicts actual revisions. A second objective was to highlight ways in which the model compares to Bayesian updating.

One hundred and nine participants (professors, students and employees of National Technical University of Athens) completed a questionnaire designed to measure their resistance. Then they were invited in groups and asked to write their degrees of belief on given propositions (A1–A4, B1–B5, C1–C5).<sup>8</sup> After the registration of the initial degrees of belief, one of the participants was randomly (via lottery) picked to play the role of the “speaker” and the remaining ones the role of the “hearers”. The speaker announced and argued for her degrees of belief and the hearers were invited to reevaluate and revise, if they wish, theirs<sup>9</sup> (participants had access to their initial reports of degrees of belief). In the end, the speaker left the room and the hearers completed a questionnaire measuring the credibility they attribute to the speaker.<sup>10</sup> This methodological design, part of the experimental philosophy field,<sup>11</sup> provided values for variables  $W_s$  and  $K_h$  and consequently for the parameters of Equation (2). By ensuring maximum validity and reliability of data collection, a comparison was carried out between the recorded empirical shifts and the shifts predicted by Equation (2).

Regarding the propositions upon which degrees of belief are attributed in order to record changes in beliefs, these fall into three thematic categories: general concepts of morality (A1–A4), psychology (B1–B5) and religion (C1–C5). All propositions were formulated with the assistance of researchers of relative academic fields, and tested by control groups. These propositions make up Questionnaire AB which measures the change in the degree of belief about the truth of a proposition. It is not a scale. It includes propositions (9 in pilot study and 14 in main study) upon which the respondents (“hearers” labeled “h”) are invited to give their certainties in the form of percentages before and after the announcement of a different degree assigned to the same propositional content from the other agent (“speaker”–“s”). Questionnaire AB is the core methodological tool of this research. It

attempts to record the extent of the hearer's revision as a possible change in the degree of belief, under which a propositional content (A, B or C) is believed by her, after she is exposed to a different degree of belief (that of the speaker). Furthermore, the theoretical sources of resistance represented by the corresponding measurement scales are: *dogmatism* (Rokeach, 1960, pp. 73–80, 413–415), *rigidity* (Rokeach, 1960, pp. 418–419), *egoism* (Weigel, Hessing, & Elffers, 1999, pp. 357–358), *self-esteem* (Rosenberg, 1965, pp. 305–307) and *ego-resiliency* (inverse coding) (Block & Kremen, 1996, p. 352). Finally, the theoretical dimensions of speaker/source credibility represented by the corresponding measurement scale are: *competence* and *character* (McCroskey & Young, 1981, pp. 33–34).<sup>12</sup> All these questionnaires provided individual estimates at the two notions in the form of percentages.<sup>13</sup>

Coming back to resistance, a note has to be made. The dimensions of dogmatism and rigidity distinguish open and closed belief systems while egoism, self-esteem and ego-resiliency refer to personality traits. Although, dogmatism and rigidity seem closer to the notion of resistance, the investigative nature of this study allowed for the testing of other traits/scales. But why not just generate resistance scores from these two scales alone? Acknowledging this possibility led to the re-analysis of the model with resistance as a sum of two, instead of five, questionnaires (see following *Analysis*).

In the pilot study the sample<sup>14</sup> initially consisted of 54 people, members of the NTUA community.<sup>15</sup> There were 11 discussion groups consisting of 5 persons each, except for one group which consisted of 4 persons. Analysis of the results (see below the analysis of main study) showed that the theoretical equation is supported to a significant extent. Of course, no absolute conformity of the empirical data to the AK model was expected but the degree of convergence between theory and empirical data was quite satisfactory. In the main study the new sample consisted of 5 groups comprised of 11 people each. The reason for this adjustment in the research setting was the finding in pilot study that small groups acted more as a team interfering with individual responses.

Answers in questionnaire AB of the pilot study displayed 84 cases where individuals revised their belief within the space  $f(\Delta_0) = \Delta_0 = |P_h(A) - P_s(A)|$  i.e. approach and 6 cases of repulsion (as described above). In 6 cases neither approach nor repulsion was recorded. In 282 cases there was no change/revision in the degrees of belief. Answers in questionnaire AB of the main study displayed 197 cases of approach, 50 cases of repulsion and 5 behaviours that were neither approach nor repulsion. In 448 cases there was no change/revision in the degrees of belief. As far as the percentages of the revisions (average value) recorded in each thematic group of propositions in questionnaire AB, measurements showed that, comparatively, the largest shift took place on propositions concerning psychology (B1–B5). Finally, measurements have shown that most cases of high credibility  $W_s$  correspond to low values of resistance  $K_h$  and a proportional relationship between  $\Delta P_h(A)$  and  $W_s$ , since most high yield credibility scores indicate a greater range of approach towards the speaker.

#### 4.1. Analysis

To allow a comparison between recorded empirical shifts and the shifts yield by Equation (2), an adjustment of statistical linear regression models was carried out. Firstly, the theoretical equation is:

$$|P'_h(A) - P_h(A)| = \Delta_0(A) \frac{W_s}{K_h + W_s} \Rightarrow \Delta P_h(A) = \Delta_0(A) \frac{W_s}{K_h + W_s}$$

Secondly, the general form of a linear regression model is:

$$Y = \alpha + \beta X + \varepsilon$$

where  $X$  is the independent variable,  $Y$  is the dependent variable,  $\beta$  is the regression coefficient and  $\alpha$  is the intercept of the model. The statistical errors are denoted by  $\varepsilon$  and a basic assumption is that they follow normal distribution with mean = 0 and a constant variance.

So, based on linear regression, the model has the following more specific form:

$\text{actual\_}\Delta P_h(A) = \alpha + \beta \cdot \left( \Delta_0(A) \frac{W_s}{K_h + W_s} \right) + \varepsilon$ , where,  $\text{actual\_}\Delta P_h(A)$  is the empirically measured revision.

For each question of questionnaire AB, scatter plots were created of the dependent variable over the independent one in order to get a first look of how they relate to each other. In several graphs, there is a tendency towards an analog linear correlation of variables indicating a positive correlation (see e.g. Appendix 1, Figure 4).

This model is per question and per person in a group, and applies only to cases of approach. Based on the theory it is expected that regression coefficient  $\beta$  to range statistically in values close to one and constant  $\alpha$  in non-zero values, although this is a secondary prerequisite for the equation.

Analysis showed that, although the mean value of constant  $\alpha$  is in most cases far from zero, standard error is quite large. Also, 95% Confidence Interval suggests that constant  $\alpha$  is rarely statistically non-zero, except for two propositions of psychological nature, i.e. B2 and B4).<sup>16</sup> This is reflected also in the weak presence of statistical significance of  $\alpha$ 's values. Research data about regression coefficient  $\beta$  show that it is statistically significant (i.e. statistically different from zero) in all adapted models, except again that of a psychology oriented proposition, i.e. B4. This means that indeed the dependent variable, i.e. the hearer's shift  $\text{actual\_}\Delta P_h(A)$  seems to be directly affected by the independent variable  $\left( \Delta_0(A) \frac{W_s}{K_h + W_s} \right)$ . Also the relatively high values of the coefficient of determination  $R^2$ , which is mostly above 0.50 (and reaching up to 83%), suggest that each independent variable explains the variability of  $\text{actual\_}\Delta P_h(A)$  in an average of more than 50%, since there is a linear relationship between variables.

Another tool for checking how these two variables change simultaneously is to estimate their correlation. For this purpose and because of the apparent linearity of scatter plots, Pearson's coefficient was applied. Data analysis showed that the values of the coefficient are rather or very high (given the very small sample) and the upper limit of the 95% CI tends very close to one, indicating a good linear relationship (analog). This means that the independent variable  $\left( \Delta_0(A) \frac{W_s}{K_h + W_s} \right)$  increases as dependent variable  $\text{actual\_}\Delta P_h(A)$  increases. An exception is again the case of proposition B4 where the correlation coefficient is not statistically different from zero and its estimate gets a negative value.

#### 4.2. A Bayesian application

Regarding the Bayesian framework, empirical prices for  $h$ 's prior probability  $P_h(A)$ ,  $h$ 's posterior probability  $P_h'(A)$  and the value of  $\varepsilon$  in evidence  $E$ , ( $P_s(A) = \varepsilon$ ) were obtained. A first question raised concerns the value of the hearer's initial degree of belief (before, that is, the announcement of the speaker) that the speaker's degree of belief in  $A$  is  $\varepsilon$  (denoted by  $P_h(E) = P_h(P_s(A) = \varepsilon)$ ). This is not measured. For, ideally, a question should have been included of the following type: "What is your degree of belief that the speaker believes 0.9 and 0.8 and 0.7 etc. this proposition is true?" In terms of procedure, that is, following her initial response ( $P_h(A)$ ) the hearer should have been informed that a specific speaker (already known to her) will announce a degree. Then, prior to any contact between them,  $h$  should have given her degrees of belief about  $s$ 's degrees of belief both generally ( $P_h(P_s(A) = \varepsilon)$ ) and under the assumption that every proposition  $A$  is true ( $P_h(P_s(A) = \varepsilon/A)$ ). But, at the beginning of each group meeting, when hearers are invited to state their degrees of belief, they do not know anything about the credibility of the speaker, simply because they do not know the speaker. Any prior acquaintance or relationship between hearer and speaker could misrepresent the under investigation causes of revision.<sup>17</sup>

Of course an obvious assumption could be that in all cases  $P_h(E) = P_h(P_s(A) = \varepsilon) = 1$ . Namely, that the hearer is absolutely sure the speaker believes what she announced. In this case the following goes: for every  $\varepsilon$ ,  $0 \leq \varepsilon \leq 1$ ,  $P_h(E) = P_h(P_s(A) = \varepsilon) = 1$ . But this possibility does not apply, because then the hearer is not coherent. Her degrees of belief will not obey the probability calculus, breaking the first necessary assumption of Bayesian rationality.<sup>18</sup> A rational agent cannot attribute one for all possible set of  $\varepsilon$ , as this would mean she is incoherent (with respect to the probability calculus). To attribute equal degrees of belief to statements in the form of  $P_s(A) = \varepsilon$  the hearer should choose in advance a finite set of possible values for  $\varepsilon$ . That is, if every possible set of  $\varepsilon$  were finite in number, only then the hearer could give the same grades of belief, and at the same time remain coherent. But, apart from the question of what this set would be, the justification of such an option raises reasonable doubts. So, based on the empirical data, Bayes' rule with strict conditionalization cannot be applied here.

However, there are issues relating indirectly to a Bayesian approach, which could be tested on the existing empirical data. One issue is the potential that for high  $W_s$ , the posterior  $P'_h(A)$  is very close to  $P_s(A)$ . If the measurements indicate so, i.e. the closer  $W_s$  is to one, the closer  $P'_h(A)$  is to  $P_s(A)$ , this could mean that there is a tendency for the speaker to be taken for an expert. When  $s$  is viewed as an expert it might apply that "expert functions" (Hájek & Hall, 2002) play a role in the model, excluding an orthodox Bayesian application of determining posterior probabilities only through strict conditionalization.<sup>19</sup> If this is the case,  $h$  must adapt her degrees of belief  $P$  in some expert function  $Q$  so that  $P(A/Q(A) = \varepsilon) = \varepsilon$  for every  $A$  and  $\varepsilon$ .

In our case, the dependence of the degrees of belief by "expert function" can be written as follows:  $P_h(A/P_s(A) = \varepsilon) = \varepsilon$ . If the findings document that for a high value of  $W_s$ ,  $P'_h(A)$  is very close to  $P_s(A)$ , then it may be argued that the respondents did not behave according to orthodox Bayesian rationality. Measurements indicate that the distribution of credibility attributed to speakers is mostly associated with cases of absolute approach [ $P'_h(A) = P_s(A)$ ], regardless of the hearer's initial degree of belief. Both in the pilot and main study, the hearers that eventually identified with the view of the speaker (absolute approach), had initially attributed more credibility to that speaker. The average credibility in the total sample of participants is  $m = 0.66$  (standard deviation = 0.13) which is (marginal) significantly higher than the average in cases of absolute approach ( $m = 0.69$ ,  $SD = 0.14$ ). In addition, when  $W_s \geq 0.8$ , absolute approaches are closer when they refer only to cases of approach between hearer and speaker. And this is consistent with the theory. So, it could be supported that credibility, as assigned by the hearers, advocates the role of the speaker as "expert".

In conclusion, analysis indicates a structural asymmetry between the AK model and the Bayesian model. It relies on the absence of a value to the hearer's degree of belief about the probability that the speaker assigns to evidence  $E$ . This leads to the emergence of a "subsequent probability" of a belief, under Van Fraassen's *Reflection Principle*. This conceptual probability represents a rational goal of any held belief at an earlier stage of opinion assessment. It allows implicitly for this model to be regarded as strictly "bipolar", i.e. that the dispositional probability of the hearer in her confrontation with a speaker/estimator about exactly the same proposition is already a "subsequent" probability. It already incorporates for the hearer every possible appreciation for this belief. So, it would be superfluous for her to look for anything beyond this "concentrated" probability when taking into account other—other than probabilities that is—factors and beginning the process of registering the speaker's "declaration" as strictly and exclusively "new data".

## 5. Overview of findings

The procedure met the postulated criteria of internal validity. A crucial element in the current approach was the reliability of repetitive measurements. That was the reason why the same measurement procedure, the same observer, the same location and the same questionnaire under the same conditions and with the repetition be performed in a short time was kept. In addition, the most important factor in achieving high credibility was the conduct of a pilot study. Limitations to the external validity of the research stem from the limited sample. An investigative study like this is not

definitive, because the sample may not be typical of the general population of interest and therefore representative. This highlights a necessity of continuation and a future expansion of this research.

As noted already, apart from approach and repulsion, empirical measurements revealed a behaviour that is not explained by either of them. For that reason it was named “unexplainable behaviour”. Its “unexplainable” nature reflected the fact that the final distance between hearer and speaker was smaller than the initial one, resembling more to an approach. But an approach that could not be explained by the theory, because, according to the equation, every approach is bounded in the space between hearer and speaker (see Figure 1). This kind of behaviour occurs when the final distance between hearer and speaker is less than the initial one,  $\Delta'_0(A) < \Delta_0(A)$  and the hearer’s revised degree of belief is located outside the approach space of their initial difference [ $P_h(A)$ ,  $P_s(A)$ ].

As already mentioned such behaviours were measured in both studies. Specifically, in main study, in 3 of the 5 cases of “unexplainable behaviours” the revised beliefs were numerically in the limit definition of that behaviour ( $\Delta'_0(A) = \Delta_0(A)$ ) representing four students and one employee. The fifth and more obvious case involved a student. As far as the corresponding six propositions of Questionnaire AB is concerned, three of them referred to psychology (B1, B3, B4) and two to religion (C2, C5). So, this “unexplained behaviour” is affected not only by the resistance of the hearer and the image of the speaker but also by the kind of proposition referred to. As already mentioned, the majority of unexplained behaviours in main study concerned the thematic of psychology. This agrees also with the findings of the linear regression analysis.

The question now is whether this kind of behaviour could be explained by theory (i.e. Equation 2). The answer is that the model cannot offer an adequate explanation, because when applied in those cases it results in a negative resistance ( $K_h < 0$ ).<sup>20</sup> This is a new finding which, prima facie, seems to be out of the model’s theoretical and explanatory scope, since by definition the resistance variable is always positive ( $K_h \geq 0$ ). This theoretical finding could be given a pragmatic interpretation. That is, provided that the hearer is exposed to the speaker’s intervention, she does not react in terms of an approach or repulsion, but revises arbitrarily, through an independent process (“a small earthquake?”) within her belief set. She converses substantially only with herself, turning against her belief set without any reason. Since this reaction is not explained either by the intervention of the speaker, nor repulsion, perhaps the hearer is inclined in advance. Or maybe it is a new initial degree of belief or attitude, since (probably) she did not allow this intervention to influence her. Therefore it could be maintained that while the hearer starts with an initial degree of belief then she makes an arbitrary personal change/revision.

Linear regression models were applied for each proposition of questionnaire AB in order for the relationship between empirical shift actual  $\Delta P_h(A)$  (dependent variable) and theoretical shift  $\left(\Delta_0(A) \frac{W_s}{K_h + W_s}\right)$  (independent variable) to be reflected. These models offered a clear picture, especially through their scatter charts. Based on the results of this adaptation, the theoretical equation appears to be confirmed to a great extent. Of course, as there can be no absolute linearity on true events, the degree of convergence between theory and empirical data is quite satisfactory. In the main study, propositions B2 (*Generally, a mother exercising (occasionally) physical violence to her child as punishment, does that because: She wants to achieve her own rest*) and B4 (*Generally, a mother ...: It is a component of her character*) displayed unwanted values of correlation.

So, in propositions of psychological nature the convergence between theory and measurements was lower compared to the other two thematic categories. It seems that the AK Model cannot be fully applied in such propositions. Furthermore it is in these propositions that most unexplainable behaviours were recorded, referring mostly to students. Of course, this “preference” on behalf of the students to this behaviour may be due to their wide participation in the sample. Yet it cannot be excluded a possible analog relationship between young age and this type of behaviour.

Finally, the concept of “subsequent probability” of a belief was introduced making unfeasible a direct comparison between AK model and Bayes’ model. Within this framework, an optimal management of limit values by the former was highlighted.

## 6. Conclusion

The revision algorithm enabled an efficient numerical treatment of personal degrees of belief. This was achieved descriptively and not through a normative standard as is customary in this field of work. Probability theory was also involved through Bayesian inference. In addition, the parameters of the AK model offered a framework for interdisciplinary research on belief revision. Although the theoretical framework of the model relates to philosophy, its research design and treatment included an interdisciplinary approach that covered part of both philosophy and psychology. Within belief revision this kind of approach is most appropriate since it was individuals and their communication that were under study and not just “rational agents” as in studies on artificial intelligence.

The metric investigation showed a “fit” behaviour of Equation (2) on its limit values (including zero values, even infinity for  $K_h$  and  $W_j$ ) and the emergence of a negative resistance. Trigger for the latter was an “unexplainable behavior” by participants on specific propositions which when recorded did not leave much room for non-analysis/investigation. It was found that its arithmetic treatment gives rise to something meaningful only if the equation contains a negative resistance, a quality value which by definition is not provided for. Negative resistance could indicate that the AK model is wrong. Nevertheless, the role of the model and at the same time its challenge is whether it explains, through this phenomenon, such empirical data. If the hearer wants to approach she would end up in the initial space of difference, why move further? The hearer’s choice to retreat could mean that she overturns her belief set with an internal process that cannot be described. She behaves, namely, in an “explosive manner”, “shaking” the belief set and resulting in a resistance that is not only zero (not caring at all) but has a negative role.

Moreover, the value of this arbitrary personal change is putting new theoretical and methodological questions within social sciences. Namely, this type of revisions could contribute to the understanding of belief change upon contemporary and crucial issues such as racism, populism, saviorism, etc. These topics, at first glance and only according to my opinion, seem to be dominated by “unexplainable behaviour” and possibly “negative resistance”.

AK Model showed also advantages over the Bayesian model. Mainly on its capacity to include zero values and therefore in the *density* of the relevant data incorporated in the hearer’s announcement of her degrees of belief. This probability is complete, rather than simply “prior” which according to Bayes needs a “posterior” etc. Thus, advantages of simpler dynamic and “naturalness” of this model versus a Bayesian one come into the picture, even in a primary stage of investigation.

Regarding possible practical applications, the model could be used as an assessment measurement tool. Especially in micro communication environments, such as management boards or jurors court, the calculation of any recipient’s response to the formulation of a claim could be used in analyzing the dynamics between group members and their collective attitude towards decision-making.

In conclusion, the main question that needs to be answered is whether the model is after all wrong or not. An adequate answer to this could only be given through new studies. Either way, two issues merit further investigation: the question whether the AK Model could capture/treat belief shifts, i.e. approaches in the form of subjective probabilities and the negative nature of resistance. An idea for further research is whether the kind of propositions has an impact on the parameters of the model, interfering with the process that leads to consensus. Within this framework, a wider thematic field of propositions could be utilized. Finally, this analysis attempted to highlight probable causes behind opinion change (i.e. the hearer’s two opposing tendencies) and how they interact with each other. The findings are pushing the determination of the nature of the prior cause behind every change of view—a cause that could be referred to as the “DNA” of interpersonal communication—more to the fore. This alone may produce a powerful stream of research towards this direction.

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### Competing interests

The author declares no competing interest.

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### Notes

1. Another model by Quignard and Baker (1997), aiming at understanding possible relationships between argumentation and cognitive change in agent interactions, was based on belief system research (along with aspects of dialogic logic and speech act theory) (e.g. Gärdenfors, 1992). It predicted revisions to beliefs (beliefs as cognitive attitudes towards propositions) that are related to sequential communication structures.
2. An important factor in this process is the nature of belief as well as all relevant information about it. Some beliefs are considered more important or more "compact" than others and thus the associated ideas (that should be withdrawn) are less important.
3. An individual's belief system is more or less flexible relative to various types of information that are received every time, claiming a place within the system (Koutoungos, 2003, p. 180).
4. Ideally, there are two possible behaviours: approach and repulsion. The case of approach refers to the space between hearer and speaker  $f(\Delta_0) = \Delta_0 = |P_h(A) - P_s(A)|$ . Repulsion occurs when the hearer is falling back in her final position, even if that means going from the other end of the line, and this position is located, relative to the speaker, further than it was initially.
5. To avoid confusion with Hogarth and Einhorn's (1992) *Belief Adjustment Model*, from now on A. Koutoungos' model will be referred to as *AK Model*.
6. For this reason, a Bayesian agent should be "non-dogmatic" in the sense that she attributes zero prior probability only to contradictions (and to all contradictions).
7. A model that uses credibility as a parameter is Thagard's (2005) *explanatory coherence* model. It refers to a standard response in which individuals, to some extent, automatically accept a request, if this is consistent with their beliefs and the source is credible. Otherwise, people enter a process in which they examine the request on the basis of explanatory coherence.

Explanatory coherence requires information on the reliability of new information taking into account all the relevant evidence including the credibility of whoever is making a claim.

8. See Appendix 1, Table 1, Questionnaire AB.
9. So, the hearer revises her initial beliefs during the speaker's speech, often occurring after revisions to her initial credibility assessments. This is the part where intuitions might be determinants of the hearer's revisions.
10. A similar survey that recorded belief change through a questionnaire before and after exposure to new information is that of Stangor, Sechrist, Jost, and Jost (2001).
11. See Alexander (2012) and Sytsma and Livengood (2015) for an overview of the literature on experimental philosophy.
12. Since credibility and resistance questionnaires were in another language (i.e. English), they had to be translated and standardized for the Greek population. One group of language experts translated them into Greek and then another group re-translated them into English to check if they would be identical to the original. Having found that the translation was accurate, the questionnaires were then pretested on a test sample consisting of experts (academics and researchers) and participants from the target population (professors, students and employees of NTUA), who evaluated whether it measures what it intends to measure (face validity).
13. At this point a clarification is needed. Although these questionnaires are established research tools, a new reliability analysis was performed. More specifically, a statistical analysis of all the initial questions of each of the five questionnaires of resistance was conducted. By considering the value of Cronbach's alpha (corrected item-total correlation and Cronbach's alpha if item deleted) 75 questions were kept out of the initial 98 in the Main Study. Then all answers to these 75 questions were summed. The higher the cumulative score, the more resistance is reported for the hearer. As far as credibility is concerned the original questionnaire consisted of 12 questions and after the same reliability analysis all 12 questions were maintained. The higher cumulative score the hearer gathers to these questions, the greater credibility she attributes to the other i.e. the speaker.
14. Participants were recruited through snowball sampling. The process was abided by the IRB's Human Subjects Protection Tutorial (Retrieved from [http://www.irb.vt.edu/documents/downloadable\\_tutorial.pdf](http://www.irb.vt.edu/documents/downloadable_tutorial.pdf)). Especially, as far as the informed consent process is concerned, the whole procedure complied with the IRB's principles of Information, Comprehension and Voluntariness of the subjects.
15. The final number of participants was 53, because as it turned out during the procedure, one of the hearers knew in advance the speaker and thus she was excluded.
16. See Appendix 1, Tables 2 and 3 for results. In Table 2 resistance is based on 5 questionnaires, whereas in Table 3 resistance is based on 2 questionnaires. A comparison between the two Tables indicates that results do not change much. Even R-squared of each model is almost or completely unchanged. Standard errors (SE) of  $\alpha$  and  $\beta$  in Table 3 are somewhat larger, something that indicates a slightly increased uncertainty in those cases. But, in general, results are quite similar. There is virtually no statistical differentiation between the 5-scale and 2-scale approach, except for an increased accuracy of the former. This proves also that the heavy

- lifting in resistance is being done by the dogmatism and rigidity scales.
17. After all the main objective of the study was the investigation of this theoretical model rather than the design and specification of measurements under Bayesian inference.
  18. Suppose that  $E$  and  $E'$  are propositions  $P_s(A) = \varepsilon$  and  $P_s(A) = \varepsilon'$  for  $\varepsilon \neq \varepsilon'$ . Then  $E'$  results in the negation of  $E$ , symbolically  $E \rightarrow \neg E'$ . But from the probability calculus, for any proposition  $A$  and  $B$  and any probability function  $P$ , if  $A \rightarrow B$  then  $P(B/A) = 1$  and  $P(A) \leq P(B)$ . So, if  $P_h(E) = 1$  and  $P_h(E') = 1$ , it applies that  $P_h(E') \leq P_h(\neg E) = 1 - P_h(E)$  and consequently  $1 \leq 1 - 1 = 0$ , which is a contradiction. Meaning that  $P_h$  is not a probability function and  $h$  is not coherent.
  19. van Fraassen's (1984) *Reflection Principle* is an "expert function" stating that the subjective probability of a proposition at some later point in time determines the subjective probability of a rational agent. The expression "at some later point in time" includes to its extent this specific point in time.
  20. In "unexplainable behaviours" the hearer's belief shift  $\Delta P_h(A)$  is greater than the initial difference between hearer and speaker  $\Delta_0$ . Namely,  $\Delta P_h(A) > \Delta_0$ . Approaching algebraically Equation (2), solve to  $\Delta_0$ , where by,  $\Delta P_h(A) = \Delta_0(A) \frac{W_s}{K_h + W_s} \Rightarrow \frac{\Delta P_h(A)}{\Delta_0(A)} = \frac{W_s}{K_h + W_s}$ . So, in cases of "unexplained behaviour" we have  $\frac{\Delta P_h(A)}{\Delta_0(A)} = \frac{W_s}{K_h + W_s} > 1 \Rightarrow W_s > K_h + W_s \Rightarrow K_h < 0$ .

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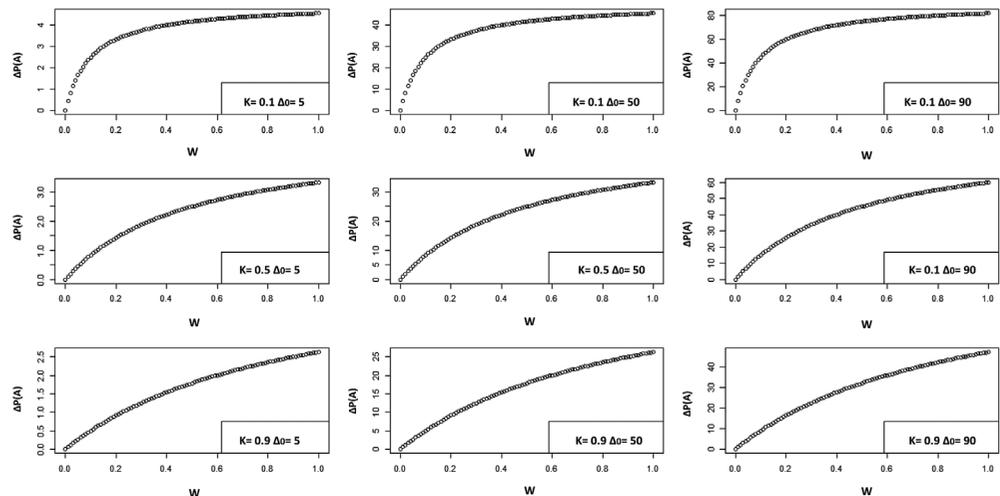
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**Appendix 1**

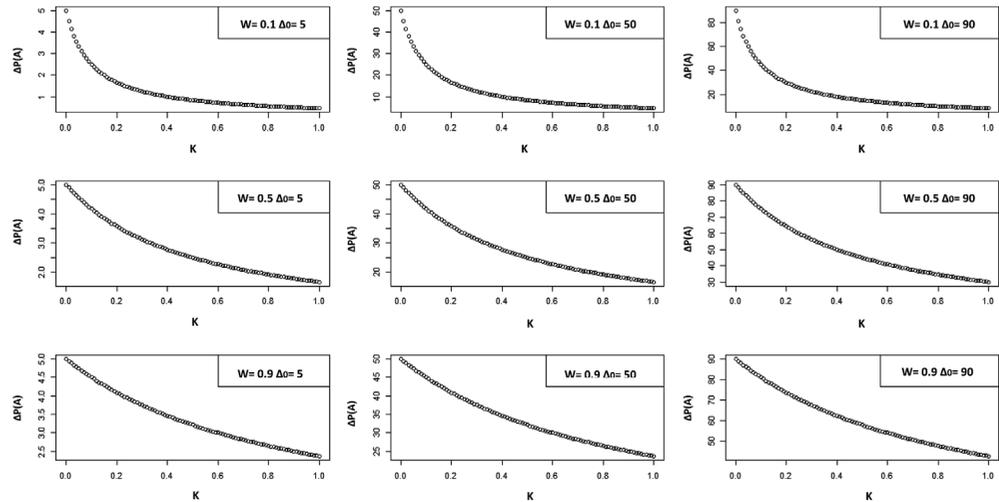
**Figure 2. Scatter plot of the theoretical value of  $\Delta P_h(A)$  based on  $W_s$ .**

Note: Each sub-graph is constructed on different combinations of parameters  $K_h$  and  $\Delta_0(A)$  with their values appearing in caption.



**Figure 3. Scatter plot of the theoretical value of  $\Delta P_h(A)$  based on  $K_h$ .**

Note: Each sub-graph is constructed on different combinations of parameters  $W_s$  and  $\Delta_0(A)$  with their values appearing in caption.



**Table 1. Questionnaire AB**

Please fill in your % of certainty for the truth of each of the following explanations of the three behaviour-considerations

A. The strongest motives behind actions related (directly or indirectly) with moral evaluations are:

Those directing our actions to the benefit (preferably, the maximum possible) of the entourage affected by them. (A1)	%
Those guiding our actions primarily for our own benefit. (A2)	%
Those underlying acts that benefit the others, but in a way that improve significantly our image. (A3)	%
Those that prevent us from actions that have, in total, undesirable (to us) consequences for others. (A4)	%

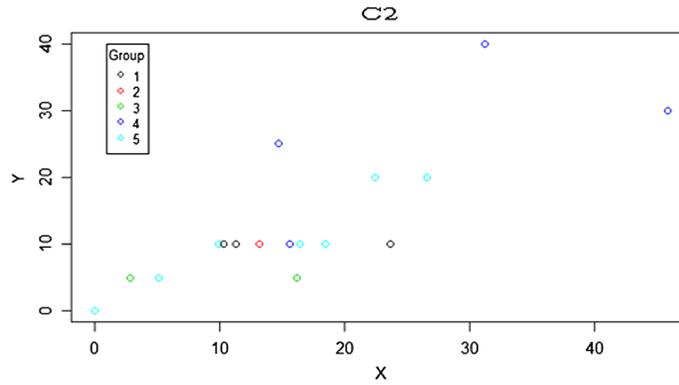
B. Generally, a mother exercising (occasionally) physical violence to her child as punishment, does that because:

This way family cohesion is practically attained. (B1)	%
She wants to achieve her own rest. (B2)	%
She wants to teach 'natural' obedience of the child towards the parent. (B3)	%
It is a component of her character. (B4)	%
She considers this to be a proven method of proper upbringing. (B5)	%

C. Do you think that a person who does not believe in God but attends church, does that:

Out of curiosity toward the content of religion. (C1)	%
To integrate socially in the environment of the church. (C2)	%
Because, nevertheless, she/he doubts about the existence of God. (C3)	%
Because, nevertheless, she/he appraises the social contribution of the gospel teachings. (C4)	%
Because she/he considers church part of the nation's tradition. (C5)	%

**Figure 4. Scatter plot of the dependent variable Y. C2 against the independent variable X. C2 for proposition C2 (colour of dots represents groups).**



**Table 2. Aggregated results of the adjusted regression models (mean, standard error SE and 95% confidence interval) for constants  $\alpha$  and regression coefficients  $\beta$  as well as the coefficient of determination  $R^2$**

Proposition	$\alpha$	SE ( $\alpha$ )	95% CI	$\beta$	SE ( $\beta$ )	95% CI	$R^2$
A1	0.62	1.88	(-3.52, 4.77)	0.67	0.11	(0.42, 0.92)	0.76
A2	1.10	1.36	(-1.78, 3.98)	0.44	0.07	(0.29, 0.59)	0.70
A3	1.21	2.13	(-4.01, 6.44)	0.45	0.11	(0.15, 0.73)	0.70
A4	2.25	1.95	(-1.97, 6.47)	0.43	0.11	(0.17, 0.67)	0.52
B1	1.68	1.24	(-0.95, 4.31)	0.51	0.09	(0.32, 0.70)	0.66
B2	5.12	2.60	(-0.54, 10.79)	0.39	0.12	(0.12, 0.64)	0.46
B3	2.78	2.56	(-2.84, 8.40)	0.61*	0.17	(0.23, 0.98)	0.41
B4	15.43*	2.49	(9.33, 21.54)	-0.18	0.09	(-0.40, 0.04)	0.39
B5	0.86	1.53	(-2.76, 4.49)	1.10*	0.18	(0.66, 1.54)	0.83
C1	0.56	2.25	(-4.20, 5.34)	0.91*	0.14	(0.59, 1.21)	0.70
C2	0.83	2.11	(-3.59, 5.27)	0.75*	0.11	(0.51, 0.99)	0.70
C3	-0.21	3.94	(-9.00, 8.57)	0.63*	0.18	(0.20, 1.03)	0.53
C4	3.53	3.10	(-3.63, 10.70)	0.41	0.12	(0.13, 0.68)	0.59
C5	0.40	1.10	(-1.96, 2.77)	0.90*	0.12	(0.63, 1.15)	0.80

\*Statistical significance.

**Table 3. Aggregated results of the adjusted regression models (resistance based on 2 scales, i.e. dogmatism and rigidity) for constants  $\alpha$  and regression coefficients  $\beta$  as well as the coefficient of determination  $R^2$ . Asterisks indicate statistical significance**

Proposition	$\alpha$	SE ( $\alpha$ )	95% CI	$\beta$	SE ( $\beta$ )	95% CI	$R^2$
A1	0.61	1.87	(-3.52, 4.73)	0.69*	0.12	(0.43, 0.94)	0.76
A2	1.08	1.36	(-1.80, 3.96)	0.45*	0.07	(0.30, 0.60)	0.70
A3	1.26	2.16	(-4.02, 6.53)	0.44*	0.12	(0.15, 0.73)	0.70
A4	2.20	1.95	(-2.00, 6.40)	0.43*	0.11	(0.18, 0.67)	0.52
B1	1.71	1.25	(-0.94, 4.38)	0.50*	0.09	(0.31, 0.69)	0.66
B2	5.26	2.63	(-0.47, 11.00)	0.38*	0.12	(0.11, 0.64)	0.45
B3	2.78	2.66	(-2.54, 8.41)	0.61*	0.18	(0.23, 0.98)	0.41
B4	15.66*	2.56	(9.37, 21.95)	-0.19	0.10	(-0.42, 0.04)	0.40
B5	0.89	1.58	(-2.83, 4.63)	1.10*	0.19	(0.64, 1.55)	0.82
C1	0.60	2.26	(-4.19, 5.39)	0.90*	0.15	(0.59, 1.22)	0.70
C2	0.75	2.14	(-3.74, 5.23)	0.76*	0.12	(0.51, 1.01)	0.70
C3	-0.22	3.95	(-9.04, 8.59)	0.63*	0.19	(0.21, 1.05)	0.53
C4	3.61	3.13	(-3.60, 10.82)	0.41*	0.12	(0.13, 0.69)	0.58
C5	0.50	1.14	(-1.96, 2.96)	0.88*	0.13	(0.61, 1.16)	0.79

\*Statistical significance.



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