Simulating the Formation and Dynamics of the Implicit Attitude: A Social Cognition Study

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Citation: Oftadehal M, Mohammadi B, Kharrazi K, Torabi Nami M. Simulating the Formation and Dynamics of the Implicit Attitude: A Social Cognition Study. Journal of Advanced Medical Sciences and Applied Technologies (JAMSAT). 2016; 2(4):291-298. http://dx.crossref.org/10.18869/nrip.jamsat.2.4.291

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Article info:
Received: 3 Aug. 2016
Accepted: 19 Oct. 2016

Keywords:
Implicit attitude formation,
Social cognition simulation,
Cognitive science

ABSTRACT

The current study aimed to define some factors contributing to implicit attitude formation mainly in the social interaction context. An agent-based computer simulation of a society, including autonomous agents and an attitude object was used to track the implicit attitude progress towards the object. The society could simulate the autonomic behaviors. We provided a complex adaptive system and observed an emergent phenomenon as the formation and dynamics of implicit attitude in the society. Our results suggested that population size and the number of high-impact individuals are important for the formation of implicit attitude in a society. Moreover, when the number of factors affecting agents' relationships increases, the dynamics of society tended to unpredictability. Our experience showed that diverse autonomous components of a society with implemented simple rules lead to emergent and seemingly organized system behavior, and the pattern of behavior can be affected by communication and environmental stress. Our study attempted to offer some key implications since few theories within the cognitive psychology and sociology have been stated in precise and unambiguous terms.

1. Introduction

Black or white? This team, or that one? Who is your favorable candidate? Which desserts do you prefer? These are life-long questions to which humans are fronted, and use their attitudes to find the answers.

Attitudes, as adaptive [1] and evaluative abstractions [2] shape people's perceptions of the social and physical world. These flexible abstractions influence behaviors strongly [3]. As pre-computed evaluations, attitudes quickly dictate our feelings towards attitude objects [4]. They have implications for persistence, resistance, and consistency of our behavior [2]. Evaluation refers to the association between an attitude object and an evaluative category [5]. The strength of the association between an attitude object, and its summary evaluations in memory [6] determines accessibility of that attitude. Accessible attitudes strongly impact our perceptions and behaviors [7].

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While the stability of highly accessible attitudes increases [8], new information may change the previously established attitudes through either perceptual comparison or comparative validation [9, 10]. Implicit attitudes represent unconscious evaluations, whereas explicit attitudes reflect our conscious assessments of an attitude object [11].

When time is sufficient and motivation is high, propositional processes (i.e. explicit attitudes) [12], underlie our attitude-guided behavior. However, implicit attitudes are highly accessible and act automatically [13], especially under time stress. In other words, the quickness of associating [12] an object to a category is an indicator of implicit attitude [14], and the ease of access to implicit attitude reveals the strength of the association. This is the concept upon which the Implicit Association Test is based [14]. It should be noted that stress is experienced differently by various people based on their type of personality. In other words, those with more adaptive personalities, such as highly extroversion and conscientiousness people, may be less affected by daily stresses [15]. Sensation seeking is yet another personality trait that affects how we respond to stress [16, 17].

It has been suggested that implicit attitudes develop through the repeated pairings of potential attitude objects with positively and negatively value-charged stimuli [18]. Attitudes are based on these accumulative value accounts, especially if cognitive capacities for self-regulation are constrained by fatigue or time pressure. Encoding of value-charged stimuli forms implicit attitude [19, 20] and activated evaluations can guide thought and behavior in the presence of the attitude object [21]. Given the importance of implicit attitudes in explaining human social behavior, the present study has focused on the process of its formation in social context.

Social processes may be simulated in a computer environment if they are computationally complete. Computational models enable researchers to test or develop theories in a way that might not be possible using analytic and experimental methods [22]. In Agent-Based Modeling and Simulation (ABMS), the interactions of individual autonomous entities with each other and with their environment are reconstructed through simple rules and in this manner a virtual social system is created. Therefore, a researcher can observe the effects of the fundamental variables on the behavior of the members of the constructed artificial society. Such a system provides an environment in which, emergent phenomena, like racial segregation, ethnic conflict [23], and group decision making [24] may be investigated. Complex social dynamics [25] may also be well studied with the ABMS, and the interaction between microand macrolevel processes be evaluated [26, 27]. However, smoothness, linearity and synchronicity are not pre-assumptions of ABMS [28]. The aim of this study was to enhance our understanding of the factors underlying implicit attitude formation, with particular emphasis on social interactions.

We were interested in the impact of communication on development of implicit attitude, and the influence of implicit attitude on social perception, judgment, and action. In the following section, we present the details of our constructed model, and examine whether or not there is any flaw in the current concepts related to implicit attitude.

2. Material and Methods

Each individual of the virtual society was represented by a computer-simulated agent, in a rectangular world. During the course of the simulation, individual agents were interacting with each other. They moved through the world in each time ticks. The length of pace for each agent was randomly assigned to the population according to the uniform distribution, but remained constant for each agent until the end of a simulation run. An agent was more likely to interact with the other agents who were in its proximity. The number of neighbors was different for each agent in a given tick. We introduced n agents with no implicit, and with various positive explicit attitudes to the world. In the initial base model, there was no attitude object (agent) in the society. In the next state, an attitude object was added to the world. The object was impacting its nearby agents. Also, individuals were capable of learning from each other and changing their behaviors, accordingly.

Based on their characteristics, the agents were diverse. Some agents were high impact ones and affecting other individuals profoundly. We considered the mean distance of the population from the object as the primary outcome, and as an indicator of both the presence of implicit attitude in the society, and behavioral change of the population.

Each individual, i.e. Agent i (Ai), was described by a vector of variables. The state of each agent was updated in discrete stages so that Ai(t) referred to the vector of values for agent i at stage t. At stage t = 0, explicit attitude EAi was randomly assigned to Ai according to the normal distribution with mean of μ and standard deviation of σ. The values of the parameters μ and σ could be selected by the user of the software. All individuals started out having zero implicit value. Thus, the initial Implicit Attitude (IA) for agent i was IAi (0) = 0. At the stage 0, heading and pace were randomly assigned to Ai using uniform distribution. The heading was determined

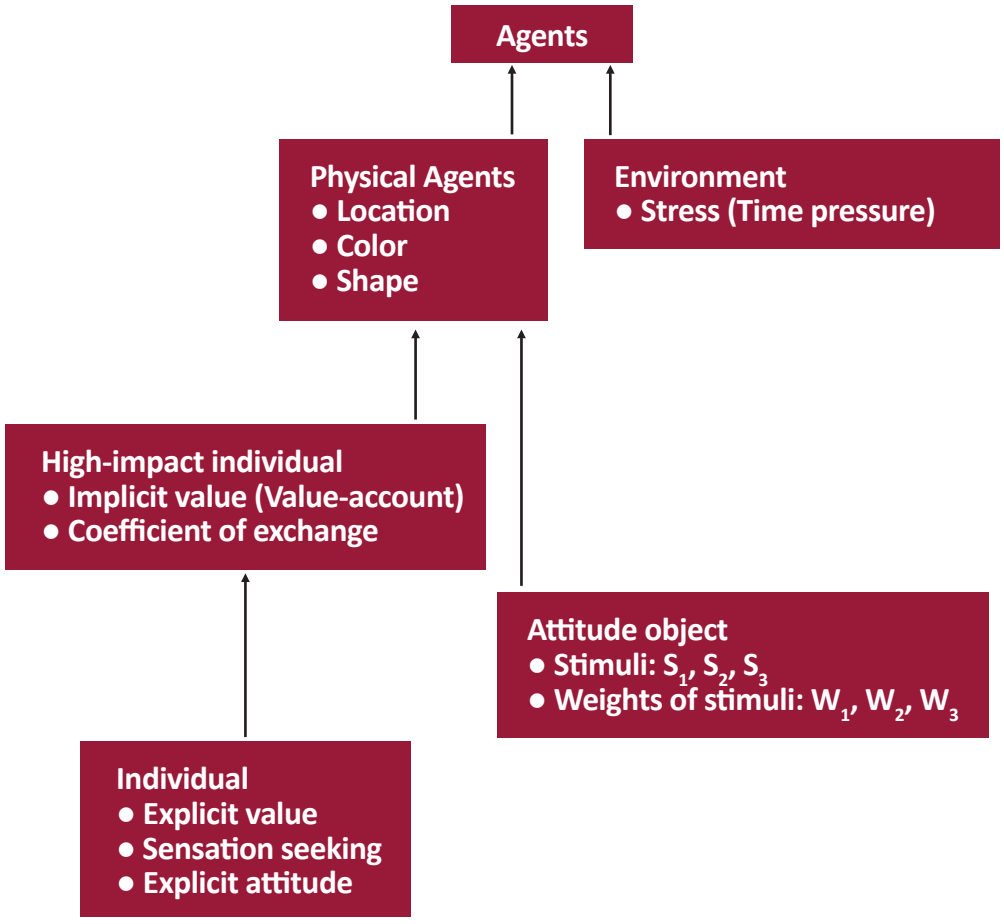

Figure 1. Inheritance tree of the model

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according to the agent's IA, but the length of each pace kept constant for Ai until the end of a run.

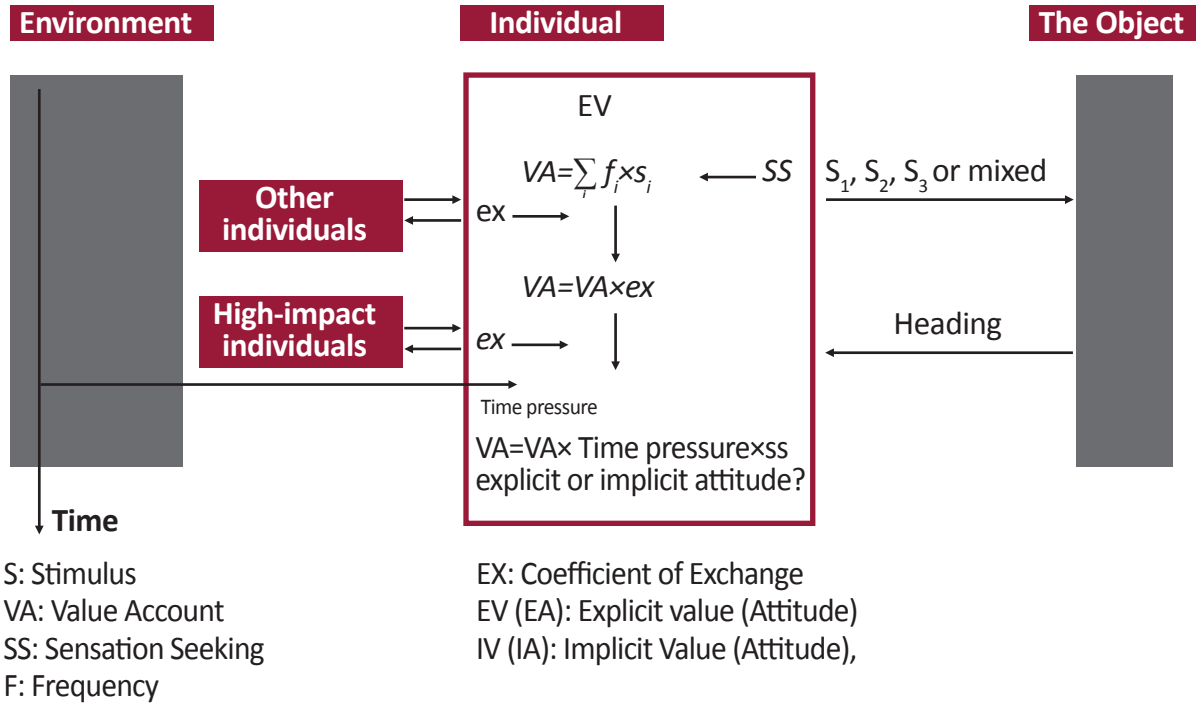

Figure 2. Sequence diagram of the model

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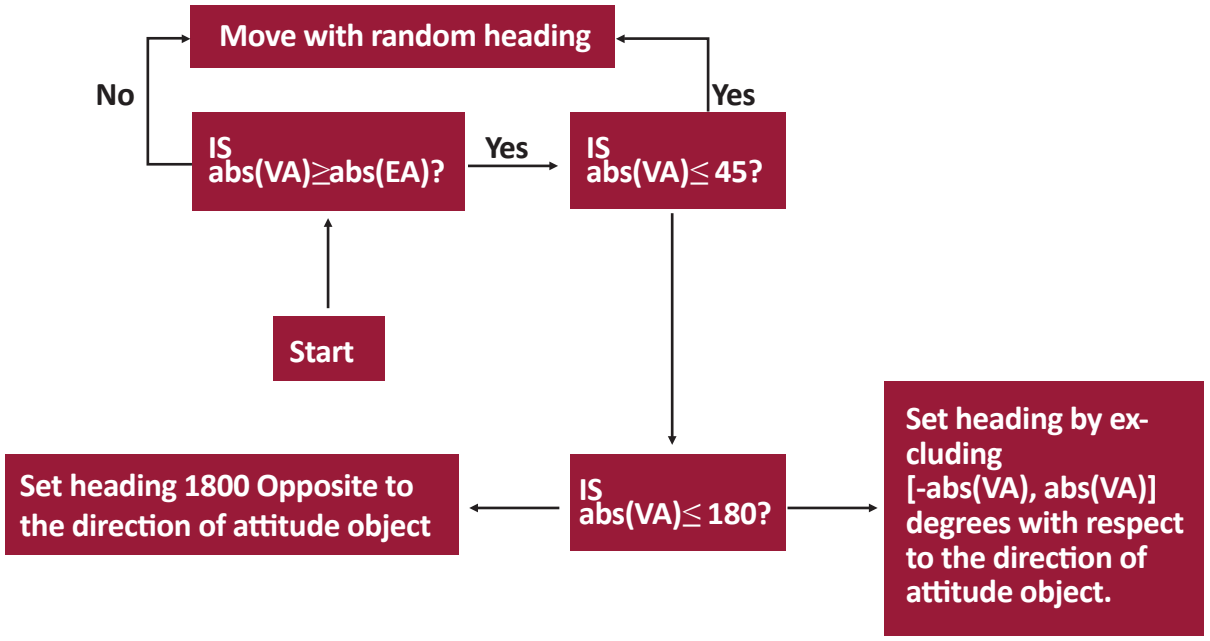

Figure 3. Flow diagram representing behavioral change according to implicit attitude (abs stands for absolute value)

We placed an attitude object O at the center of the world. The object was capable of stimulating neighboring agents with three different values. In our model, the charges of stimuli were determined by the user, while the frequencies of encounters were out of the user's control. The value account served as the basis to form an attitude judgment about the target object O. If an agent found that the experience was negative, it would be inclined to go away from the attitude object.

The agents were communicating with each other and were able to share their experiences and attitudes (implicit or explicit). As a representative of varying degrees of relationship, the extent of the exchange was determined by a coefficient; ex ∈[0, 0.5]. The coefficient ex was randomly assigned to Ai according to the normal distribution with the mean value of 0.25 and standard deviation of 0.05. We considered some high impact individuals (e.g. elite and famous members of a society) as a distinct breed with ex = 1. It should be noted that d was not measured for high impact agents, and therefore, it was not involved in the calculations.

The value account is more easily accessible in memory than explicit attitude. In our model, individuals relied more frequently on an already established evaluation (implicit attitude) under stress. We imposed time pressure tp ≥ 1 on the system of which the value was a factor of VA, and was determined by the user. Furthermore, each agent had a specific coefficient of sensation seeking ss ∈[0.1] which represented the difference in personalities, and in the acceptance of the stress. The coefficient of ss was distributed normally among the population with a mean of 0.5, and standard deviation of 0.1. Figures 1 and 2 show the implementation scheme of the model. Agents changed to implicit attitude, if the absolute value of their IA was more than or equal to EA. At each time tick, VAi determined the heading of Ai with respect to the location of the attitude object O (Figure 3). Each simulation run took 1000 ticks to complete, and d was estimated for the population for each tick.

3. Results

We ran the entire simulation almost 12000 times. As the primary outcome and the representative of IA, d was evaluated for each simulation. Initially, we set time pressure = 1, object's sum of stimuli = 0, and the number of high impact individual = 0. With this initial set-up, and with various population sizes there were no implicit attitude or behavioral change. However, in the presence of negative stimuli, alteration of the variables made the system to act differently. Agents were stimulated negatively by the attitude object. They communicated with each other, and exchanged their experiences with different coefficients of exchange, ex. The random coefficients of sensation seeking ss impacted their value account, VA. Finally, VAs were mapped into headings, and thus, a visible behavior was created in the society. Figure 4 demonstrates some snapshots of the formation of IA among our virtual society.

Figure 5 shows the effect of the number of agents on d. A population of 120 or fewer individuals failed to gener-

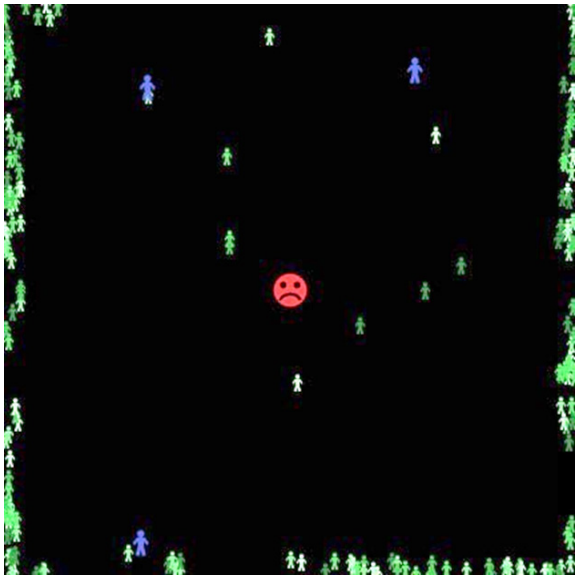

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Figure 4. Snap-shots of the formation of IA represented by the change in behavior. Green agents are ordinary members of the society, and blue agents are high-impact individuals with the maximum coefficient of ex. At the center of the world there is an attitude object which is able to stimulate neighboring agents.

ate an observable change of behavior. The maximum IA increased when the number of agents was more than 140.

Figure 6 illustrates how introducing different numbers of high-impact individuals to the population changed the value of IA. Adding more high-impact agents to the population caused the value of IA to increase more rapidly. The

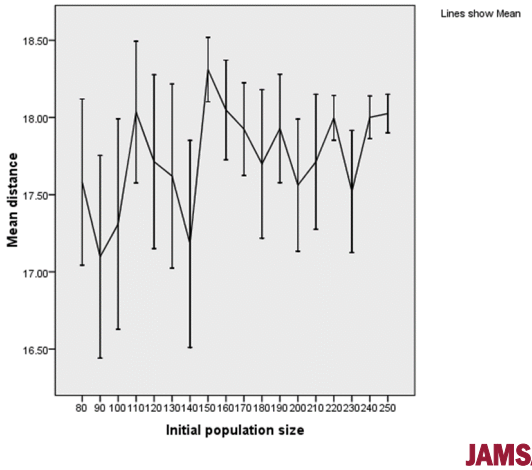

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Figure 6. Average mean distance from the attitude object versus initial population sizes in the presence of negative stimuli when the number of high impact individuals increased while other variables were fixed. Vertical bars represent 95% confidence in- terval. Each point on the curve stands for 30 episodes of simula- tion.

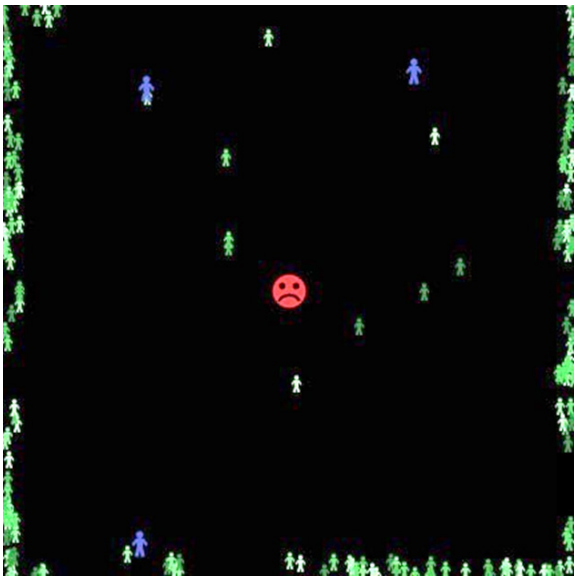

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Figure 5. Average mean distance from the attitude object versus initial population sizes in the presence of negative stimuli when other variables were fixed.

figure shows that the confidence intervals gets wider and the general pattern of the curve begins to distort, when population size and high impact individuals increase. This means that as the interactions increase in the volume and variety, society grows unpredictable in its behavior.

We investigated the effect of varying the coefficient of ex in mean distance. A coefficient of 3% or less was unable to cause propagation of IA among the population.

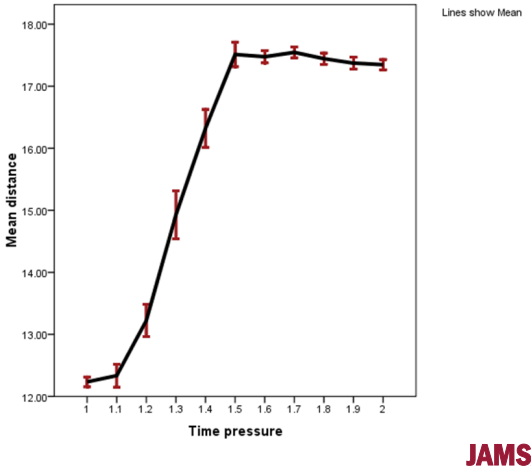

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Figure 7. Average mean distance from the attitude object versus time pressure in the presence of negative stimuli when other variables were fixed. Vertical bars represent 95% confidence interval. Each point on the curve stands for 30 episodes of simulation. We used NetLogo version 4 (Wilensky, 1999) to construct the system. Data was visualized with a statistical software package (SPSS for Windows, version 11.5, SPSS, Inc., Chicago, IL, USA).

In addition, increasing EA caused a delay in the formation of IA. By raising the values of the stimuli which the attitude object was applying to the environment, we saw changes in behavioral pattern as the manifestation of increasing VA. The effect of the coefficient of time pressure on IA was evaluated as well. By increasing time pressure from 1.2 to 1.5, an observable change was identified in the pattern of IA formation (Figure 7).

4. Discussion

We carried out an agent-based computer simulation of a society, including autonomous agents and an attitude object, and tracked the progress of the implicit attitude to the object. Construction of the model was based on the available theories and on the results of many previous studies on the implicit attitude formation and dynamism. Agents were discrete individuals with a set of characteristics and rules governing their behaviors and decision-making capability. Attitude formation was reflected in turning away of agents from an attitude object.

Agents had memory within them, learned from their environment, and changed their behaviors in response. The inter-relationships between agents enhanced the impact of learning on their behaviors, and this was apparent when we increased the population size. They also contained higher-level set of rules to change the base-level rules. These provided adaptability to the components of the society. Of course, the agents were not highly sophisticated. Agents were diverse in their attributes, and the attributes were mainly determined by the use of random numbers with uniform or normal distributions.

Therefore, the society was able to simulate autonomic behavior. Briefly, we provided a complex adaptive system and observed an emergent phenomenon as the formation and dynamics of implicit attitude in the society.

5. Conclusion

Our results suggested that population size is important for the formation of IA in a society. Also, high-impact individuals play crucial roles in shaping people's perceptions of the social and physical world. The high-impact entities could be considered as the media, famous individuals, or reference people. Most graphs in our research were of sigmoid type. Alteration of the variables in the direction of increasing information exchange in the society commonly shifted the curves to the left, where other variables remained fixed. Meanwhile, Alteration in more than one variable concomitantly distorted the sigmoid pattern. In other words, when the number of factors increased, the dynamics of society tended to unpredictability.

Previously, it has been assumed that many aspects of human behavior roots from higher order processes of deliberate reasoning. However, more recently, researchers regard them as resulting from automatic processes that may occur spontaneously and outside of awareness or conscious control [29, 30]. Our experience showed that diverse autonomous components of a society with implemented simple rules lead to emergent and seemingly organized system behavior, and the pattern of behavior can be affected by communication and environmental stress. It was not necessary to design highly intelligent agents in order to elicit the desirable response.

Designing a model is easier if there is already a body of theory. To our knowledge, there is no recent study on the social dynamics of IA. Despite an extensive review, a limitation of our study was the shortage of report on quantitative research in the literature. We were unable to check completeness or faithfulness of the model during the abstraction process, and were unable to compare the outputs of the system with real data. Therefore, our study may yield an important implication since few theories within cognitive psychology and sociology have been stated in precise and unambiguous terms.

Verbal theory specifications are generally open to interpretation. Another main criticism on the previous studies of agent-based modeling in the social science was the lack of standard methodologies. Our results are consistent with previous theories on observational and social learning reported in the literature [31]. It has been suggested that individual's behavior is impacted by their observation of the behavior of others because of the information contained therein [9, 32-34].

Some researchers believe that observational learning can occur, as long as the underlying decision problems are similar among individuals, regardless of time, space and whether individuals are socially connected. In contrast, social learning takes place through direct communications and necessitates social proximity [35]. Our agents revealed observational learning via direct contact with the attitude objects, and reinforced social learning by communicating with other individuals in their society, as well.

Conceptualization and quantitative description of personality traits as the filters of communication are fundamental for the simulation of societies. When supported by real data, decision support models are designed to answer real-world policy questions. These models should

pass some validation tests to establish credibility. Simulation of stressful situations may help social policymakers to be ready for crises, and to investigate the impact of tension on social or organizational cognition. The role of memory or attention in theory formation can be considered as a basis for further research.

Acknowledgement

The current research hasn't received any financial support.

Conflict of Interest

The authors declared no conflict of interests.

References

[1] Fazio RH. Accessible attitudes as tools for object appraisal: Their costs and benefits. Why we evaluate: Functions of attitudes. 2000; 1-36. doi: 10.4135/9781446263037

[2] Crano WD, Prislin R. Attitudes and persuasion. Annu Revew of psychology. 2006; 57(1):345-74. doi: 10.1146/annurev.psych.57.102904.190034

[3] Crano WD, Prislin R. Attitudes and attitude change. Newyork: Psychology Press; 2011.

[4] Zanna MP, Rempel JK. Attitudes: A new look at an old concept. In: Bar-Tal D, Kruglanski AW, editors. The Social Psychology of Knowledge. Cambridge: Cambridge University Press; 1988.

[5] Albarracín D, Johnson BT, Zanna MP, Kumkale GT. Attitudes: Introduction and scope. In: Albarracín D, Johnson BT, Zanna MP, editors. The Handbook of Attitudes. New York: Psychology Press; 2005.

[6] Fazio RH, Towles-Schwen T. The MODE model of attitude-behavior processes. In: Chaiken S, Trope Y, editors. Dual Process Theories in Social Psychology. New York: Guilford; 1999.

[7] Fazio RH, Ledbetter JE, Towles-Schwen T. On the costs of accessible attitudes: detecting that the attitude object has changed. Journal of personality and social psychology. 2000; 78(2):197-210. doi: 10.1037/0022-3514.78.2.197

[8] Fazio RH. On the power and functionality of attitudes: The role of attitude. In: Pratkanis A, Breckler SJ, Greenwald AG, editors. Attitude Structure and Function. Hillsdale, N.J.: Erlbaum; 1989.

[9] Maio GR. The psychology of human values. Oxford: Psychology Press; 2016.

[10] Pham MT, Muthukrishnan AV. Search and alignment in judgment revision: Implications for brand positioning. Journal of Marketing Research. 2002; 39(1):18-30. doi: 10.1509/jmkr.39.1.18.18929

[11] Banaji MR, Lemm KM, Carpenter SJ. The social unconscious. In: Tesser A, Shwarz N, editors. Blackwell Handbook of Social Psychology: Intraindividual Processes. Oxford: Blackwell; 2000.

[12] Gawronski B, Bodenhausen GV. Associative and propositional processes in evaluation: an integrative review of implicit and explicit attitude change. Psychological Bulletin. 2006; 132(5):692-731. doi: 10.1037/0033-2909.132.5.692

[13] Fazio RH. Multiple processes by which attitudes guide behavior: The MODE model as an integrative framework. Advances in Experimental Social Psychology. 1990; 23:75-109. doi: 10.1016/s0065-2601(08)60318-4

[14] Greenwald AG, McGhee DE, Schwartz JL. Measuring individual differences in implicit cognition: the implicit association test. Journal of Personality and Social Psychology. 1998; 74(6):1464-80. doi: 10.1037/0022-3514.74.6.1464

[15] Vollrath M, Torgersen S. Personality types and coping. Personality and Individual Differences. 2000; 29(2):367-78. doi: 10.1016/s0191-8869(99)00199-3

[16] Zuckerman M. Sensation seeking: Beyond the oprimul level of arousal. Hillside, N.J.: Lawrence Erlbaum; 1979.

[17] Zuckerman M. Broad or narrow affect scores for the multiple affect adjective check list? Comment on Hunsley's "dimensionality of the multiple affect adjective check list-revised". Journal of Psychopathology and Behavioral Assessment. 1990; 12(1):93-7. doi:10.1007/BF00960456

[18] Olson MA, Fazio RH. Implicit acquisition and manifestation of clasically conditioned attitudes. Social Cognition. 2002; 20(2):89-104. doi: 10.1521/soco.20.2.89.20992

[19] Baumeister RF, Vohs KD. Self regulation, ego depletion, and motivation. Social and Personality Psychology Compass. 2007; 1(1):115-28. doi: 10.1111/j.1751-9004.2007.00001.x

[20] Betsch T, Plessner H, Schwieren C, Gütig R. I like it but I don't know why: A value-account approach to implicit attitude formation. Personality and Social Psychology Bulletin. 2001; 27(2):242-53. doi: 10.1177/0146167201272009

[21] Fazio RH, Powell MC, Herr PM. Toward a process model of the attitude–behavior relation: Accessing one's attitude upon mere observation of the attitude object. Journal of Personality and Social Psychology. 1983; 44(4):723-735. doi: 10.1037//0022-3514.44.4.723

[22] Gorman DM, Mezic J, Mezic I, Gruenewald PJ. Agent-based modeling of drinking behavior: A preliminary model and potential applications to theory and practice. American Journal of Public Health. 2006; 96(11):2055-60. doi: 10.2105/ajph.2005.063289

[23] Penzar D, Srbljinović A. Dynamic modeling of ethnic conflicts. International Transactions in Operational Research. 2004; 11(1):63-76. doi: 10.1111/j.1475-3995.2004.t01-1-00439.x

[24] Sellers WI, Hill RA, Logan B. An agent-based model of group decision making in baboons. Philosophical Transactions of the Royal Society B: Biological Sciences. 2007; 362(1485):1699-710. doi: 10.1098/rstb.2007.2064

[25] Hegselmann R. Understanding social dynamics: The cellular automata approach. Paper presented at: The Confer-

ence of Social Science Microsimulation. London, United Kingdom; 1996.

[26] Bryson JJ, Ando Y, Lehmann H. Agent-based modelling as scientific method: A case study analysing primate social behaviour. Philosophical Transactions of the Royal Society of London B: Biological Sciences. 2007; 362(1485):1685-99. doi: 10.1098/rstb.2007.2061

[27] Bryson JJ, Ando Y, Lehmann H. Agent-based models as scientific methodology: A case study analyzing the Dom-World theory of primate social structure and female dominance. Modelling Natural Action Selection. 2011; 427-53. doi: 10.1017/CBO9780511731525.024

[28] Adra S, Sun T, MacNeil S, Holcombe M, Smallwood R. Development of a three dimensional multiscale computational model of the human epidermis. PloS one. 2010; 5(1):8511. doi: 10.1371/journal.pone.0008511

[29] Bargh J. Automaticity of everyday life. In: S R, Wyer Jr, editors. Advances in Social Cognition: vol. 10. Newyork: Psychology Press; 1997.

[30] Moors A, De Houwer J. Automaticity: A theoretical and conceptual analysis. Psychological bulletin. 2006; 132(2):297-326. doi: 10.1037/0033-2909.132.2.297

[31] Bandura A. Social foundations of thought and action: A social cognitive theory. Michigan: Prentice-Hall; 1986.

[32] Banerjee AV. A simple model of herd behavior. The Quarterly Journal of Economics. 1992; 107(3):797-817. doi: 10.2307/2118364

[33] Bikhchandani S, Hirshleifer D, Welch I. A theory of fads, fashion, custom, and cultural change as informational cascades. Journal of Political Economy. 1992; 100(5):992-1026. doi: 10.1086/261849

[34] Sun R. Cognition and multi-agent interaction: From cognitive modeling to social simulation. Cambridge: Cambridge University Press; 2006.

[35] Cai H, Chen Y, Fang H. Observational learning: Evidence from a randomized natural field experiment. American Economic Review. 2009; 99(3):864-82. doi: 10.1257/aer.99.3.864