The Bystander Effect: Agent-Based Simulation of People's Reaction to Norm Violation

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Abstract. The bystander effect is a well-known phenomenon in criminology, stating that bystanders tend to inhibit people's tendency to intervene in situations where norms are violated. This paper presents an agent-based simulation model of this phenomenon. The simulation model presented demonstrates the decision process of an agent for norm violation situations with different characteristics, such as high versus low personal implications. The model has been tested by performing a number of case studies. The outcome of these case studies show that the model is able to represent the behaviour of bystanders as expected based on various experimental studies.

Keywords: Bystander effect, Psychology, Cognitive modelling, Agent-based Simulation, Norm violation.

1 Introduction

In 1964 a young woman, named Kitty Genovese, was stabbed to death right outside of the apartment building in which she lived [1]. A newspaper claimed that 38 neighbours witnessed the event for half an hour but did not intervene. This claim was later proven inaccurate (no one could actually observe the entire assault), but the fact that a woman was murdered while bystanders observed part of the attacks (screaming, people fighting) without intervening is shocking. This case has been the starting point of research into the phenomenon of (non-)intervention (or the so-called bystander effect).

The main goal of the research presented in this paper is to develop a simulation model of the effect bystanders can have on people's reaction to a situation that (potentially) needs intervention e.g. because of norm violation or in case of an emergency.

The results of this study can be used in different domains. In the field of criminology, it may be useful to gain more insight in the mechanism of the bystander effect. This can help answering questions like: When do bystanders intervene? and What factors can help increase the number of interventions?

In the area of artificial intelligence this research can be helpful to create more realistic agents. These agents can be used for training purposes (e.g. for police agents) in a simulated setting, but can also be interesting in virtual societies (e.g. second life).

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In this paper, the theory of the bystander effect will be explained in more detail in Section 2. In Section 3 an overview of related work is shown to demonstrate the innovative aspects of this study. The modelling approach and the simulation model are explained in Sections 4 and 5 and Section 6 shows a case study to illustrate the model. The paper is concluded with a discussion section (Section 7).

2 Bystander Effect

Bystander effect is a term used in a situation when people base the decision of acting in a certain situation (e.g. a norm violating situation or an emergency situation) on their bystanders. Imagine being in a situation in which intervening might be necessary e.g. you see someone falling on the ground. This could be caused by a heart attack, but maybe the person just tripped over his shoelace. Do you decide to help or not?

Research by [2, 3] demonstrated that the presence of other people decreases our willingness to help a victim in an emergency situation. Later studies, which are described in the next section, demonstrated that this is not only the case in emergency situations, but also for example in case of norm violations.

The main problem seems to be that people do not know how they should act in a given situation. They are not unwilling to help but do not know if their interpretation of the situation is correct. They seek for confirmation by looking at the behaviour of other bystanders, and let social cognition have a large influence on their behaviour.

Latané and Nida [4] distinguish three social psychological processes that might occur when an individual is in the presence of other people to explain their social inhibition of helping namely *audience inhibition* (you run the risk of embarrassment if you decide to intervene while you misinterpreted the situation), *social influence* (you confirm to the behaviour of others) and *diffusion of responsibility* (reduction of the psychological costs of non-intervention. Why should you help while all the other bystanders are also capable but do not do a thing?)

3 Related Work

In Section 3.1 an overview is given of related work in the area of social psychology. Similarly, in section 3.2 an overview of related work in the area of agent-based simulation is provided.

3.1 Social Psychology

In the field of social psychology a number of studies have been performed to investigate the effect of bystanders on behaviour. As mentioned in the previous section [2, 3] demonstrated that the presence of other people decreases our willingness to help a victim in an emergency situation.

Later studies demonstrated that the presence of others not only decreases our willingness to help in an emergency situation but that people are also less likely to answer the door [5], or leave a large tip in a restaurant [6] in the presence of others.

Chekroun and Brauer [7] conducted field studies to explore the influence of the number of bystander-observers on the likelihood of social control. The results of their

studies make clear that perceived personal implication moderates the extent to which people are inhibited by the presence of others when they decide whether they should exert social control or not.

The difference between the current research and the work mentioned above is the approach. The researchers of the mentioned articles conduct field studies to investigate the effect of a certain action on the behaviour of bystanders, with the number of bystanders as dependent variables. In the research presented in this paper, methods from the area of agent-based simulation are used to analyse the decision-making process, on a cognitive level. No real life experiments have been performed, but a model has been developed to simulate behaviour, given different parameters.

3.2 Agent-Based Simulation

In the last decades, there has been a growing interest in the area of Agent-Based Social Simulation (ABSS). In ABSS, which integrates approaches from agent-based computing, computer simulation, and the social sciences, researchers try to exploit agent-based simulation to gain a deeper understanding of social phenomena [8].

This approach has been used in a large number of studies, some of which address the criminological domain. For example in [9] an agent-based modelling approach has been presented for decision making, which integrates rational reasoning based on means-end analysis with personal psychological and biological aspects. In this project the authors use the same approach as presented in the current paper, namely simulating a decision process. However, the domain that they investigate is the domain of decision making in the case of street robbery while the work presented here focuses on the effect of bystanders on intervention.

Other ABSS studies in the field of criminology are the work by [10], which presents a model of deterrence with emphasis on the social network and the perceived sanctions. The paper leaves the mental aspects unaddressed, while the current paper also focuses on the cognitive aspect of the decision making process.

In [11], the authors model the process of emotion contagion. The focus is on cognitive aspects as is the focus of the model presented in the current paper. However, the authors do not apply their model to a real life situation.

With respect to norm violating behaviour many formal approaches exist. In [12] and [13] approaches for representing norm-governed multi-agent systems are introduced. More specific for norm violation, in [14] procedural norms are discussed that can for example be used to motivate agents that play a role in recognizing violations or applying sanctions. In [15] a formalism is introduced to detect, sanction and repair violations of norms. The difference between these papers and the research presented in the current paper is that we focus specifically on norms in a human situation instead of norms in software agents.

4 Modelling Approach

To model the various relevant aspects of the bystander effect in an integrated manner poses some challenges. On the one hand, qualitative aspects have to be addressed, such as desires, and intentions, and some aspects of the environment such as the

observation that an action occurs and that the other bystanders do not intervene. On the other hand, quantitative aspects have to be addressed, such as the number of bystanders and the level of seriousness of the norm violation.

The modelling approach based on the modelling language LEADSTO [16] fulfils these requirements. It integrates qualitative, logical aspects and quantitative, numerical aspects. This integration allows the modeller to exploit both logical and numerical methods for analysis and simulation. LEADSTO enables to model direct temporal dependencies between two state properties in successive states by means of *executable dynamic properties*, which are comparable to rules as occurring in specifications of a simulation model; for example:

If *in the current state, state property p holds,*
then *in the next state, state property q holds*

Here, atomic state properties can have a qualitative, logical format, such as an expression desire(d), expressing that desire d occurs, or a quantitative, numerical format such as an expression belief(norm,y) which expresses that y is a threshold above which actions are considered norm violations. For more details of the language LEADSTO, see [16]. Based on LEADSTO, a dedicated piece of software has been developed [16]. The LEADSTO Simulation Environment takes a specification of executable dynamic properties as input, and uses this to generate simulation traces.

5 Simulation Model

The decision model for a single agent consists of a set of LEADSTO rules. The model is depicted in Figure 1. The model of the decision making process shown in Figure 1 is inspired by the so-called BDI-model [17]. The BDI-model bases the preparation and performing of actions on beliefs, desires and intentions. It incorporates a pattern of reasoning to explain behaviour in a refined form. Instead of a process from desire to action in one step, as an intermediate stage first an intention is generated. An action is performed when the subject has the intention to do this action and it has the belief that the opportunity to do the action is there. The BDI model is extended by introducing rules that formalise the theory by [4]. The model consists of rules to determine the belief that the agent is personally responsible, to determine the desire to help, the belief that there is an opportunity to help and eventually to perform the action. These sets of rules are explained below.

Personal responsibility

LP1 "If you observe that others do not intervene this leads to the belief that intervention will be evaluated negatively (*social influence*)":

observe(no_intervention_by_others) →belief(intervention_will_be_evaluated_negatively)

LP2 "If you observe a number of bystanders present then you will believe that the bystanders can observe you":

∀n:INTEGER
observe(number_of_bystanders(n)) → belief(others_observe_me(n))

LP3 "If you observe an action and you believe that others can observe you and that intervention will be evaluated negatively this will lead to the belief of *audience inhibition* with value n":

∀a:ACTION ∀n:INTEGER
observe(a) ∧ belief(others_observe_me(n)) ∧ belief(intervention_will_be_evaluated_negatively)
→ belief(audience_inhibition(n))

LP4 "The number of bystanders that you observe determines your belief about the costs of intervention. The higher the number of bystanders the higher the costs (*diffusion of responsibility*)":

∀n:INTEGER
observe(number_of_bystanders(n)) → belief(costs_intervention(n))

LP5 "Your belief about the costs of intervention combined with your belief of audience inhibition determines your belief on personal responsibility. The lower the costs and audience inhibition the higher the belief of personal responsibility":

∀n1, n2:REAL
belief(audience_inhibition(n2)) ∧ belief(costs_intervention(n1)) ∧ n1<thn1 ∧ n2<thn2 →
belief(personal_responsibility)

The thresholds used in LP5 (thn1 and thn2) are linked to the level of seriousness. If you believe that a certain violation is very serious, and thus feel highly personally implicated then you will probably less likely let the costs of intervention or audience inhibition stop you from intervening. The threshold for non-intervention is high. However, if you believe a violation is not serious at all, then you will let the costs and audience inhibition keep you from intervening. In this case the threshold for non-intervention will be low.

Desire to help

LP6 "When you observe an action and you believe that this action has a seriousness of value s and you see that there are bystanders present and that these bystanders do not intervene then this leads to the belief that the level of seriousness of the action is s divided by the amount of bystanders times α. Here, α is a parameter that determines the influence of the group; α is by default set to 0.5. You adjust your opinion on the level of seriousness based on the non intervention of the others":

∀s:REAL ∀a:ACTION ∀n:INTEGER
observe(a) ∧ observe(no_intervention_by_others) ∧ observe(number_of_bystanders(n)) ∧
belief(has_seriousness(a,s)) → belief(seriousness, s/n^α)

LP7 "If you belief that the action has a level of seriousness of x and you belief that a certain norm has value y and the action violates the norm (x>y) then you believe that there is an emergency":

∀x,y:REAL
belief(seriousness, x) ∧ belief(norm,y) ∧ x>y → belief(emergency)

LP8 "If you believe that there is an emergency then you have the desire to help":

belief(emergency) →desire(i)

Intention to help

LP9 "When you believe that you are personally responsible to help, and you have the desire to help then you have the intention to help":

desire(i) ∧ belief(personal_responsibility) → intention(i)

Opportunity to help

LP10 "If you belief that you are capable to help and have the required resources then you believe that you have the opportunity to help":

belief(capable(i)) ∧ belief(resources(i)) ↠ belief(opportunity_for(i))

Performance of Action

LP11 "The intention to help combined with the belief that you have the opportunity to help leads to the actual intervention":

intention(i) ∧ belief(opportunity_for(i)) ↠ perform(i)

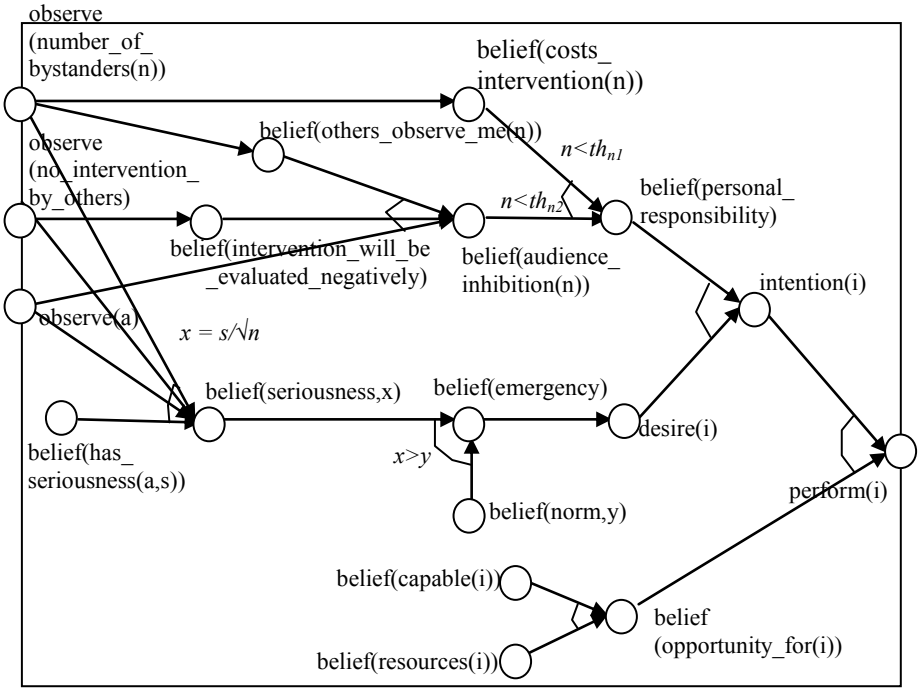

Fig. 1. Simulation model

6 Case Studies

To illustrate the behaviour of the model we present two case studies: one case study with a norm violation in a situation with high personal implication and one case study with a norm violation in a situation with low personal implication. Recall that personal implication indicates the level of responsibility a person feels for a particular situation: when you feel it is your duty to intervene in a certain situation you feel highly personally implicated (e.g. when someone damages something in your home). However, when you do not feel any responsibility to intervene, you have a low

personal implication (e.g. when you see someone shoplifting). The norm violating situations used in the case studies are based on the experiments presented in [7].

In Section 6.1 the case studies will be described and the results of the simulations are shown in Section 6.2.

6.1 Description

Low personal implication

Chekroun and Brauer [7] conclude that whether or not people feel personally implicated, has a great impact on their incentive to intervene. According to their research people feel low personal implication in case of a norm violation in an elevator in a shopping mall. This is caused by the fact that the shopping mall belongs to a corporate business and professional cleaning personnel is responsible for keeping the shopping mall clean.

In their experiment [7], a young man is waiting for the elevator. When people join him, he enters the elevator with them. Once the doors are closed, he takes out a marker and draws something on the wall. He gives the other people in the elevator the opportunity to react, before leaving the elevator at the first floor. The results of the experiment show that the number of bystanders has an effect on the intervention rate. The more bystanders were present, the lower the probability that someone expressed his or her disapproval.

High personal implication

People feel highly personally implicated in situations in which they feel it is their personal obligation to intervene. Chekroun and Brauer [7] use a park as a situation in which people feel highly personally implicated. The maintenance of the park is paid via local taxes and thus by the inhabitants. Further, aspects with respect to rising consciousness about the environment play an important role in feeling personally implicated.

To test the intervention behaviour and the effect of bystanders, the following experiment was performed in [7]. Two females are walking through a park. As soon as they approach other people, they start to drink from a plastic bottle and throw the bottle in the bushes. They make sure that all bystanders notice this. Then they walk away, and give the bystanders the opportunity to react to the littering.

The results of this experiment show that in this case, the number of people present does not affect the intervention behaviour of the bystanders.

6.2 Example Simulation Traces

We have used the situations described in Section 6.1 as scenarios to demonstrate our model. For each of the situations (low personal implication and high personal implication), we have run the simulation model with various parameter settings for the amount of bystanders, the value of the norm and the level of seriousness.

Table 1 shows the parameter settings (first four columns) and results (last four columns) of some of these runs. The first column shows how many bystanders are present. The second column indicates the agent's behavioural norm. A norm with

value 0.1 means that the agent believes very quickly that norms are violated; while a value of 0.8 means that the agent will not believe this very quickly. The seriousness (column 3) determines how serious the agent believes a certain action usually is (0.1 means that an action is not considered to be very serious, while an action rated with 0.9 is considered to be very serious). The value for the thresholds used in LP5 (thn1 and thn2, which are currently taken equal) is mentioned in the fourth column. Based on these settings, the fifth column shows the updated seriousness (which is the result of the calculation performed by LP6), i.e., the agent's perceived seriousness of an action in one particular situation. The final three columns show whether or not the agent feels responsible to intervene, has a desire to intervene and performs an intervention.

Table 1. Results simulation runs

#by-standers	norm	serious-ness	threshold	updated seriousness	personal responsibility	desire	inter-vention
1	0.1	0.2	2	0.20	yes	yes	yes
3	0.1	0.2	2	0.18	no	yes	no
4	0.1	0.2	2	0.17	no	yes	no
5	0.1	0.2	2	0.17	no	yes	no
1	0.1	0.5	5	0.50	yes	yes	yes
3	0.1	0.5	5	0.45	yes	yes	yes
4	0.1	0.5	5	0.44	yes	yes	yes
5	0.1	0.5	5	0.43	no	yes	yes
1	0.1	0.9	9	0.90	yes	yes	no
3	0.1	0.9	9	0.81	yes	yes	yes
4	0.1	0.9	9	0.78	yes	yes	yes
5	0.1	0.9	9	0.77	yes	yes	yes
1	0.5	0.1	1	0.10	no	no	yes
3	0.5	0.1	1	0.09	no	no	no
4	0.5	0.1	1	0.09	no	no	no
5	0.5	0.1	1	0.09	no	no	no
1	0.5	0.5	5	0.50	yes	no	no
1	0.5	0.6	6	0.60	yes	yes	no
1	0.5	0.9	9	0.90	yes	yes	yes
3	0.5	0.9	9	0.81	yes	yes	yes
4	0.5	0.9	9	0.78	yes	yes	yes
5	0.5	0.9	9	0.77	yes	yes	yes
1	0.8	0.9	9	0.90	yes	yes	yes
2	0.8	0.9	9	0.84	yes	yes	yes
3	0.8	0.9	9	0.81	yes	yes	yes
4	0.8	0.9	9	0.78	yes	no	no

These results show that the model is able to reproduce the behaviour as found in the experiments performed by [7]. Indeed, intervention depends on the amount of bystanders and the personal commitment. The number of bystanders is important in the low personal implication scenarios (seriousness 0.1-0.5), while the bystanders do not have a large effect on the intervention behaviour in the high personal implication scenarios (seriousness 0.6-0.9).

7 Discussion

In this paper we have developed a simulation model to demonstrate the behaviour of bystanders in norm violating situations. This model was tested in two case studies

with multiple different scenarios. In these case studies we used situations with low and high personal implication and tested the model with different settings for the number of bystanders, the level of the norm, seriousness of the violation and thresholds. The results of the simulations show that the model can replicate the behaviour of the agent as expected based on the results of various real life experiments [7].

The model can be useful in different domains. In the field of criminology the model can support researchers to gain more insight in the decision process behind the bystander effect. For instance: Under what circumstances will people intervene? Do they intervene when they see someone stealing a bike? Or when someone gets murdered like in the Kitty Genovese case?

Within the domain of Artificial Intelligence, the results are interesting for the development of more realistic virtual agents. These agents play an important role, e.g., in training simulations for police officers. Thus, the model can be used as a first step in developing 'virtual bystanders' for such applications.

Finally, the results can also be helpful for policy makers. For instance, it may provide ideas about how to change environmental design in such a way that bystander interventions are encouraged. This might make it possible to reduce the amount of police effort, and thus to reduce costs.

This paper is a starting point of agent-based simulation in the area of the bystander effect. Future work will include research into other relevant aspects (e.g., environmental aspects of the location of the violation, appearance of the offender), and to a more extensive validation of the model.

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