Victim no more: a temporal-causal analysis of how a mediator can help out a bullying victim

Fakhra Jabeen, Nizar A. Hirzalla, Thomas M. Maaiveld, Charlotte Gerritsen and Jan Treur

Social AI Group, Vrije Universiteit Amsterdam, Amsterdam, Netherlands

ABSTRACT
Bullying is an intentional abusive behaviour, caused by a power imbalance, which can leave long-lasting effects over the mental and physical health of a victim. In order to combat such situations, victims need someone that can help them, a mediator who is able to reduce the oppression. This paper presents temporal-causal network models related to victimization and its support, based upon social and cognitive literature. The aim of the study is to explore responses of a victim after being bullied and how a mediator can support a victim. Here, a ‘fight or fly strategy’ is presented along with the role of mediator in order to support a victim. Subsequently, the model is tuned and analysed with respect to derived empirical data. Lastly, simulation experiments are compared with a publically available dataset, to verify the behaviour of the model.

1. Introduction
Bullying is pushing someone around and making them feel like a failure … like if you are beating someone up, that is bullying, and also if you are blackmailing or threatening them, that is bullying. …. If it is playful teasing, no, but if you are hurting someone’s feelings, yes. (Espelage & Asidao, 2001)

As expressed by this sixth-grade student (Espelage & Asidao, 2001), many students recognize bullying as unwanted behaviour, that results from an interaction between a dominant individual (bully) and a less dominant individual (the victim). This aggressive behaviour is intended to cause distress to the victim (Dan, 2013), and can be of any form like verbal (e.g. threats), physical (e.g. assault) or relational harassment (e.g. exclusion from the society) and many more (Grotpeter & Crick, 1996). Cyber or electronic bullying adds other dimensions to traditional bullying, i.e. ‘anonymity’ and ‘prevalence’. It can cause poor mental or...
physical health (Kowalski, Giumetti, Schroeder, & Lattanner, 2014; Vaillancourt et al., 2008), due to depression, or anxiety (Ortega et al., 2012). A victim might face social rejection, loneliness, embarrassment and even few cases of peer victimization end up with suicide ideation (De Leeuw, de Boer, & Minnaert, 2018; Kashdan et al., 2014; Klomek, Sourander, & Gould, 2010). Mediators like teachers, parents or friends can play an important role by intervening into such situations (Craig, Henderson, & Murphy, 2000).

Wide research has been conducted in the domains of sociology (Sondergaard, 2012; Thornberg & Knutsen, 2011), psychology (Ortega et al., 2012; Sandstrom 2004) and computer science (Bellmore, Calvin, Xu, & Zhu, 2015) with the perspective of detection of bullying behaviour and, to devise appropriate support strategies to control the bullying and victimization (Craig et al., 2000). Many questionnaire-based studies were conducted for the self-reported prevalence of bullying and thus, anti-bullying policies were installed by school teachers and staff (Yang & Salmivalli, 2015). In the field of artificial intelligence different techniques are applied to detect bullying, and to sensitize students about bullying (Huang, Singh, & Atrey, 2014; Zoll, Enz, Schaub, & Paiva, 2006). Artificial intelligence can also address qualitative reasoning of biological, social, psychological and cognitive processes through ‘causal modelling’ (Scheines, Spirtes, & Glymour, 1991; Treur, 2016). In this paper, we aim to address the cognitive processes, i.e. (a) how the internal processes work out to help a victim to decide his or her response to bullying and (b) which characteristics of a mediator can play role in order to take appropriate action to avoid peer victimization and how to support and improve the internal processes of the victim to be ‘no more victim’.

The paper is organized as follows. In Section 2, we discuss the state of the art. In Section 3, the methods and methodology are discussed and, in Section 4, we explain the simulation experiments. Sections 5 and 6 address the parameter tuning and mathematical analysis, respectively. Section 7 discusses relevance to a publically available data set, and lastly, Section 8 concludes the paper.

2. State of the art

In this section, we present the state of the art for peer victimization and the role of a mediator within a situation of victimization in the context of behavioural, cognitive and social literature. In Section 2.1, we explain about the bullying victim and his possible reactions towards the bully. Section 2.2 elaborates the role of mediator in the perspective of comforting/counselling the victim.

2.1. Bullying victim

Various studies have been carried out which indicate the prevalence of bullying, for example, a meta-analysis was conducted which indicated that 36% of participants were involved in traditional bullying, while 15% were found the victims through social media (Modecki, Minchin, Harbaugh, Guerra, & Runions, 2014). Among the victims, some approach their bully, to stop them by mentioning their concerns to the related behaviour (Brent, 2016), and some avoid their bully to keep themselves safe from further victimization (Lund, Ertesvåg, & Roland, 2010). Another study of 269 undergraduate students indicated that, students who were bullied in early age felt excluded and rejected from their
society. They didn’t know how to fight back and felt threatened by some physical harm (Adams & Lawrence, 2011). Also, many victims justified their reactive anger as an action of ‘self-defense’ (Brent, 2016).

A stress-coping framework is addressed which incorporates the ‘approach or avoid’ strategy to control aggression and stress (Roth & Cohen, 1986). In ‘avoid strategy’, the victim prevents the stressor in order to de-escalate himself; however, in ‘approach strategy’, victim targets the stressor and attempt to regulate his feelings (Gross, 2015). This is also known as ‘flight or fight’ behaviour that emerges from a threat situation (Kunimatsu & Marsee, 2012), and it is also addressed in our previous work (Hirzalla et al., 2019). However, the aim of both reactions is intended to defend oneself from bullying situations and to avoid future harms. The literature addresses four kinds of feeling that are associated with both of the responses (Kowalski et al., 2014; Ortega et al., 2012): the fear (depression) or threat of getting hurt emotionally or physically, feelings of anger, feelings of rejection or social isolation, and feelings of sadness which arise due to the bullying behaviour. The cognitive attributions like ‘People hate me’ make the victims to resolve bullying situation by changing school, but they still remain at high risk of new victimization experiences (Smokowski & Evans, 2019). Moreover, students applied externalizing approaches in order to resolve these situation, which usually included approaching the stressor (De Leeuw et al., 2018). Usually, the victims lack emotion regulation skills and therefore, reactive aggression is an expected outcome, which is negatively correlated with sadness (Giménez Gualdo, Hunter, Durkin, Arnaiz, & Maquilón, 2015). Two groups of victims were emerged based on deviant behaviour and reactions. A group that was characterized by withdrawal (fly) felt more anxiety and, the other group (fight) was characterized by aggression and self-control deficits (Smokowski & Evans, 2019). Similarly, some useful regulation techniques (like situation modification or situation selection and so on) are presented along with different consequences, that can be applied to the people’s core valuation systems, or to the people in the surrounding, to cope the negative feelings (Gross, 2015).

Machine learning algorithms are also presented in the field of artificial intelligence to detect bullying. For example, bullying can be detected through sentiments or visual connotations (Silva, Santos, & Barbosa, 2019). It can also be detected by analysing text and social circle in which bullying messages are exchanged (Huang et al., 2014). Similarly, in causal modelling, an approach called temporal-causal modelling is used to show how a bully behaves when a victim is spotted online (Jabeen & Treur, 2018). However, very little research is done that can address the ‘bullying victims’ (Hirzalla et al., 2019), furthermore, the authors didn’t came across any artificial intelligence-based research to support victim from the stress he faced after being bullied (Sandstrom 2004).

2.2. Mediator and his role

Although very few students self-reported that they have been victimized, it is observed that when bullying is experienced mediators like parents, teachers or friends often try to intervene to reduce its aftermaths. In most of the cases, bullying happens when a mediator is not around (Elliott, 2002). There is a large ratio of peer victimization in schools and, it further amplifies with the involvement of internet technology due to ‘anonymity’ (Kowalski et al., 2014; Rigby & Smith, 2011). Therefore, being informed can play a pivotal role in order to decrease bullying and its effects (Elliott, 2002; Novick & Isaacs, 2010).
A mediator usually tries to get involved into the matter, by listening both of the bully and the victim, for the reason their point of view matters when an adult has to take a decision. Upon enquiry, a bully may often use terms like ‘just playing’ or ‘I just tapped’, while the victim may address something like ‘he was rude’ or ‘nothing’ with a face value. In these kind of situations, a communicative mediator should encourage them to talk and should show kindness or ‘empathy’ in order to listen and interpret the situation. Giving the students feeling of mutual respect and ‘trust’ can help the victims to address their problems openly, so that the mediator can make a clear decision. A teacher can arrange activities by considering their ‘power’ in order to maintain a bullying free environment (Craig et al., 2000; Elliott, 2002). The feeling of trust establishes ‘telling’ and ‘discussion’ as a norm, as it can happen to anyone. The confrontation from mediator resulted in a feeling of courage to stand up against bullies. Moreover, a mediator can help to build self-respect and can assure him for not being alone (Elliott, 2002).

As another perspective, understanding the intensity of bullying is necessary to devise goal-oriented anti-bullying policies (Yang & Salmivalli, 2015). In a study, it was observed that, when the students informed their mediator(s), like teachers and found them really concerned and trying to control bullying, their own attitude was less related to reaction towards bullying or otherwise (Elliott, 2002; Veenstra, Lindenberg, Huitsing, Sainio, & Salmivalli, 2014). Although there is a lot of literature available with respect to the role of a mediator, however, it would be interesting to study the behaviour through causal modelling to see how a victim can be supported and to see what factors are required to make anti-bullying programmes more strong and efficient (Yang & Salmivalli, 2015).

3. Methods and methodology

To provide an in-depth understanding of human behaviours, a qualitative approach known as ‘causal modelling’ is widely used in the field of artificial intelligence (Kuipers, 1984; Scheines et al., 1991). Temporal-causal network models distinguish themselves by adding a temporal perspective in the causal relations, i.e. relations change over the time. Temporal-causal models are widely applicable varying from mental, biological to social networks and beyond. This section will describe the temporal-causal modelling approach (Treur, 2016), along with the temporal-causal models of the bullying victim and the mediator.

A temporal-causal model is usually represented by its conceptual and numerical representation. A conceptual representation uses states and connections which are based on real-world scenarios. A connection is a causal relationship among two or more states. To illustrate it further, consider two related states X and Y with a causal relationship represented by $X \rightarrow Y$. This indicates that X has an influence on state Y. The activation level of Y is computed through its combination function, which uses the aggregated causal impact of all the incoming states for Y. The aggregated causal impact varies due to connection weights and the activations of the incoming states.

- **Connection weight** $\omega_{X,Y}$ indicates that how strong state X will influence state Y. The suppression of a state is shown by a negative connection. The magnitude of the connection weight varies in the range of 0–1.
• **Speed factor** $\eta_Y$ indicates that how fast $Y$ should change its value upon the aggregated impact. The range is between 0 and 1. Lower values indicate a slower change of the state for a given aggregated impact.

• **Combination function** $c_Y(\ldots)$ is used to compute the aggregated causal impact of all incoming states ($X_i; i = 1 \text{ to } k$) to state $Y$. Certain standard combination functions are available in a library to compute the aggregated impact of a state.

A conceptual representation can also be **numerically represented** as (Treur, 2016):

1. Impact of state $X$ on $Y$ at time $t$ is computed as $\text{impact}_{X,Y}(t) = \omega_{X,Y} X(t)$, where $\omega_{X,Y}$ is the connection weight of state $X$ to state $Y$, and $X(t)$ is the value of state at time $t$. The value of impact varies between 0 and 1.

2. Aggregated impact on $Y$ at time $t$ is computed by applying the combination function of state $Y$ to all incoming impacts

   $$\text{aggimpact}_Y(t) = c_Y(\text{impact}_{X_1,Y}(t), \ldots, \text{impact}_{X_k,Y}(t))$$

   where $X_1, \ldots, X_k$ represent the $k$ incoming states of $Y$. Here, $\omega_{X,Y}$ is the connection weight of $X \rightarrow Y$, and $c_Y$ is the combination function that is used to compute the aggregated impact of incoming states to $Y$, for example, identity, scaled sum, advance logistic functions and so on.

3. The effect of the aggregated causal impact of $Y$ at time $t$ on the value of $Y$ at $t+\Delta t$, is controlled by its speed factor $\eta_Y$

   $$Y(t + \Delta t) = Y(t) + \eta_Y[\text{aggimpact}_Y(t) - Y(t)]\Delta t$$

   and

   $$\frac{dY(t)}{dt} = \eta_Y[\text{aggimpact}_Y(t) - Y(t)]$$

4. The difference and differential equations can be rewritten as

   $$Y(t + \Delta t) = Y(t) + \eta_Y[c_Y(\omega_{X_1,Y} X_1(t), \ldots, \omega_{X_k,Y} X_k(t)) - Y(t)]\Delta t$$

   and

   $$\frac{dY(t)}{dt} = \eta_Y[c_Y(\omega_{X_1,Y} X_1(t), \ldots, \omega_{X_k,Y} X_k(t)) - Y(t)]$$

### 3.1. A temporal-causal network model of a victim

Being bullied is not an instantaneous process, but it is usually started when a victim is noticed nearby (in a school or a play yard) or online. The literature addresses that a victim may choose ‘fight or flight’ strategy to react to his/her bully (Hirzalla et al., 2019). This section shows the conceptual representation of the bullying victim model (Figure 1) along with a description of each state (Table 1). The model consists of 44 states, which are designed based on the literature discussed in Section 2. A state in the model is connected by any of the three types of arrows showing the influence of one
Figure 1. Temporal-causal network model of bullying victim.
We would like to discuss the model in two streams. Firstly, we will look at the bully influencing the victim, and secondly, we will investigate how a mediator (agent) could influence the bullying situation.

### 3.1.1. Victim responses to bullying

The victim gets a stimulus from a bully (esb), while using the social media or being in his/her school (wss). After sensing this bullying behaviour (sensory state: sss,b) and its respective representation states are activated. The feelings of reactive anger (fsang;psang), and threat or fear (states: fsth, psth) (e.g. physical harm), make him approach the bully by activating respective preparation and execution states (papp, esapp). While approaching, the victim is fully aware of his action, therefore the self-attribution states: the retrospective (ros) and prior ownership states (pos) are activated. Here, the feeling of sadness is suppressed so as a result, ‘fight strategy’ is a reactive outcome of bullying and it will influence his/her bully as well (ssb), which is input to the bully model (Jabeen & Treur, 2018; Smokowski & Evans, 2019).

However, the reaction of the bullying victim is different, if he feels rejected from society (fsrej;psrej) as he internalizes bullying messages (e.g. ‘People hate me’, ‘why even try’). The feelings of sadness/depression (fssd), threat or fear (fsth, psth) and rejection (fsrej;psrej) make him to avoid his bully. The victim prefers to walk away or change his situation (e.g. changing school (Smokowski & Evans, 2019), or blocking the bully) in order to ignore the bully, thus respective preparation and execution states are active (psavd, esavd).

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**Table 1. Categorical explanation of the states of the model of victim.**

| Categories | References |
|------------|------------|
| **Stimulus states** | esb, Input from aggressor/bully (stimulus) |
| | wss, World state for stimulus |
| | ss,b, sensory state of stimulus |
| | ssrs,b, representation state for stimulus |
| | estrust, trust earned from the mediator behaviour |
| **Feeling and body states (emotions)** | for threat (th), anger (ang), sad (sd), rejection (rej), courage (cou), respect (res), and not alone (nal); fs, Feeling state i = th/ang/sd/rej/cou/res/nal |
| | ps, Preparation state i = th/ang/sd/rej/cou/res/nal |
| | ssrs, Representation state i = cou/res/nal |
| | es, Execution state i = cou/res/nal |
| **Avoidance (avd) and approach (app) states** | ps, Preparation state i = avd/app |
| | es, Execution state i = avd/app |
| **Belief state (esteem)** | bs, Esteem of a victim |

| Feelings and body states (emotions) | ‘The-as-if body loop hypothesis entails that the brain structures in charge of triggering a particular emotion be able to connect to the structures in which the body state corresponding to the emotion would be mapped.’ (Damasio, 2012) |
|---|---|
| Avoidance (avd) and approach (app) states | ‘Emotion then facilitates behavior that is in line with our concerns’ (Zeelenberg, Nelissen, Breugelmans, & Pieters, 2008) |
| Belief state (esteem) | ‘effects such as depression, loneliness, low socializing, low self-esteem, anxiety are seen in victims’ (Ayas, 2014) |
The activation of esavd lowers world state ws indicating that the victim is choosing the avoidance response. This is known ‘situation selection’, one of the emotion regulation strategies (Gross, 2015) to avoid his/her bully. His control state (csn) is also activated in both of the reactions, the aim is to monitor and regulate the negative feelings and their respective preparation states.

3.1.2. Role of a mediator to comfort the bullying victim

The literature shows that a mediator can help in mediating the bullying situation. This is done when the victim gets the stimulus (for example, a talk) from his mediator or defender, and a comfortable atmosphere to talk (Elliott, 2002). These two stimuli are shown by states ws (stimulus) and es_trust (from mediator). This discussion helps him by making his esteem (bs) high, which will help him to be courageous, self-respectful and not feel alone (Craig et al., 2000; Elliott, 2002), shown by respective feeling, preparation and execution states (courage: fs_cou, ps_cou, es_cou; self-respect: fs_res, ps_res, es_res; not being alone: fs_nal, ps_nal, es_nal).

Discussion with the mediator will help him to lower the negative feelings which arose due to the victimization. For example, courage will reduce the feeling of threat or fear, making him bold enough to face the situation and defend himself. An example can be that the victim acknowledge that mediator is well aware of his action and he warns his bully to stop bullying (a reactive action). Similarly, being part of a social environment and not being alone will help him not to be a victimized further as mostly victims are characterized as ‘lonely people’ (Elliott, 2002).

For simulation, connection weights and speed factors were assumed to be in the range [0,1]. The value of ws and esp is 1. Different combination functions were used to determine the aggregated causal impact of the states. For example, for the states ss,sbr, pos, ros, ps_angr, ps_sd, ps_th, es_avd, ss_cou, ss_trust, ss, ss_res, ss_nal, ss_nal, the identity function id(V) = V was used. States ss,sbr, es_app used scaled sum function ssum(1 + e−σ(ν1 + ... + νk))). Here, λ represents the scaling factor, which is equal to the sum of incoming positive weights for a state. For the rest of the states (cs, ps_app, fs_angr, fs_rej, fs_th, fs_sd), an advanced logistic sum function was used:

\[
\text{alognistic}_{σ,τ}(ν1, \ldots, νk) = \left[ \frac{1}{1 + e^{-σ(ν1+\cdots+νk)}} \right] - \left( \frac{1}{1 + e^{τ}} \right)(1 + e^{-στ})
\]

where σ is the steepness of the curve and τ = the threshold

3.2. Temporal-causal model of the mediator

A mediator has the capability to manage the communication between the two agents. A mediator can be a teacher, parent or both of them or someone who aims to support the anti-bullying environment. The aim is to deal with the situation in such a way that both agents can earn trust and concern from the mediator (Elliott, 2002) and the mediator is able to counsel the victim. This section depicts the conceptual representation of the temporal-causal model of the mediator. As our scope is limited to the victim, hence, we aim to explain our model with the states which can be related to help out the victim. The conceptual representation shows 19 states (Table 2), of the model (Figure 2), which are connected by black arrows, indicating that the model has positive connections, thus mediator will
Table 2. Categorical explanation of states of the model of the mediator.

| Categories                               | References                                                                                                                                 |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Stimulus states of victim (v) and bully (b) | ‘the representation of the world external to the body can come into the brain only via the body itself’ (Damasio, 2010)                  |
| World state for stimulus, \( i = v/b \)  |                                                                                                                                           |
| Sensor state for stimulus, \( i = v/b \)  | ‘They need to know that this person will listen to their fears, take them seriously and do something’ (Elliott, 2002)                   |
| Representation state of stimulus \( i = v/b \) |                                                                                                                                           |
| Cognitive attribution states              | ‘When the mind is informed of the actions taken by our organism, the feeling associated with the information signifies that the actions were engendered by our self.’ (Damasio, 2010) |
| Belief state \( i = v/b \)                |                                                                                                                                           |
| Evaluation state \( i = v/b \)            | ‘Emotion then facilitates behavior that is in line with our concerns’ (Zeelenberg et al., 2008)                                        |
| Preparation state \( i = v/b \)           |                                                                                                                                           |
| Ownership state of action \( i = v/b \)    |                                                                                                                                           |
| Execution state of action \( i = v/b \)    |                                                                                                                                           |

Figure 2. Temporal-causal model for mediator.
take appropriate action ($ps_{act} \& es_{act}$) based upon his positive feelings (empathy; power and trust) related to the action.

The mediator listens to the bully and his victim, which is shown by input states: $ws_b$ and $ws_v$ (an example can be setting up a joint meeting). This will activate the respective sensory and sensory representation states ($ss_{sb}$, $ss_{sv}$; $sr_{sb}$ and $sr_{sv}$) of the mediator. The mediator uses his/her belief ($bs$) to evaluate (eval) the received inputs from peers (bully and victim). His thinking capabilities (PFC) will prepare him to act in an appropriate manner, this is indicated by the respective preparation and execution states ($ps_{act}$; $es_{act}$). In order to resolve the matter, he is self-aware of his action ($os$). The associated positive feelings are: empathy ($fsp_{eemp}$) for the victim, power to battle against bullying to resolve the matter ($fspow$). Moreover, such an action will increase the feeling of trust for the mediator himself ($fstr$), and it is expressed to the victim, by the execution state ($estr$). This acts as a positive input for the victim model (as $estrust$), so that he can discuss openly, and eventually his negative feelings fade away.

For the simulation of the model, connection weights and speed factors were assumed to be in the range of [0,1]. As mediator aims to act as a referee here, so he takes two inputs/stimuli: from the bully and the victim, so the value of $ws_b$ and $ws_v$ is 1. Different combination functions were used to determine the aggregated causal impact of the states. For example, for the states $ss_{sv}$, $ss_{sb}$, $es_{sb}$, $sr_{sb}$, $PFC$, $ps_{eemp}$, $ps_{pow}$, $ps_{tr}$ and $es_{tr}$ used the identity function: $id(V) = V$. States $eval$, $os$, $fstr$ used scaled sum function:

$$\text{ssum}_\lambda(V_1, \ldots, V_k) = \frac{V_1 + \ldots + V_k}{\lambda}.$$  

Here, $\lambda$ represents the scaling factor, which is equal to the sum of incoming positive weights for a state, while rest of the states ($bs$, $ps_{act}$, $es_{act}$, $estr$) used alogistic combination function

$$\text{allogistic}_{\sigma, \tau}(V_1, \ldots, V_k) = \left[ \frac{1}{1 + e^{-\sigma(V_1 + \ldots + V_k)}} - \frac{1}{1 + e^{\tau}} \right] \left[ 1 + e^{-\sigma} \right].$$

where $\sigma$ is the steepness of the curve and $\tau$ is the threshold.

Detailed descriptions of the models are mentioned online (Jabeen, 2020). To simulate our model, we used Excel and Matlab software environments (Treur, 2016). The numerical representation of the model was also used for mathematical verification of the model, which is described in Section 6 of the paper.

4. Simulation experiments

Simulation experiments of the temporal-causal models offer insights about the dynamics of the models. In this section, we present the simulation scenarios related to the (a) bullying victim response strategies and (b) the role of the mediator to comfort the victim.

4.1. Bully victim response strategies

After being bullied, the victim can respond in two ways, either he can (a) avoid the bully or he can (b) approach the bully to control the bullying.

4.1.1. Avoidance strategy

There are many example scenarios that can address this kind of reaction or strategy chosen by a victim. For example, ‘They called me bad names, and I didn’t know what
else to do than walk away from them’ (Lund et al., 2010). This example scenario is shown in the simulation results that are depicted in Figure 3.

When a victim is confronted with bullying behaviour (esb = 1), whether in school or through social media (ws = 1), the sensory state (sss,b: yellow) and sensory representation state (srs_s,b: black) start to increase. In this scenario, the victim choose to avoid his/her bully, so the avoidance response (psavd: magenta with asterisks) is activated. Subsequently, the respective feeling and preparation states also start to increase: threat (fsth: blue; psth: brown), sadness (fs_sd: green; ps_sd: purple) and loneliness/rejection (fs_rej = bright green; ps_rej = orange) are activated before time point t = 10. Here, the ps_app stays low, as the victim chooses to avoid the bully. The avoidance strategy is also reflected by the state world state (ws: mustard), which starts to get low with the passage of time. This results in a decline of sss,b and the following states as well. This pattern is expected, since avoidance ceases the interaction with the bully. Although the bully is still there (esb = 1:pink), the victim decides not to be victimized by simply avoiding him. Here, we can see that cs is activated at time point t = 8; however, it can be seen that negative feelings (sadness; threat and rejection) are not lowered or suppressed value = 0.9, due to poor regulation (Gross, 2015).

4.1.2 Approach strategy

In this scenario, the victim chooses to approach the bully to make him stop the bullying behaviour. For example ‘There were two boys who would call me names and say that I looked like a girl. That hurt me so much that I would see a red haze and I would punch and kick them’ (De Leeuw et al., 2018)

The victim is victimized as he is noticed by his/her bully, for example, being in a playground or being online on social media. Therefore, the input states of the model are activated already (ws and esb = 1), which activates the preparation state of the approach action (ps_app: purple with asterisks) after the sensory (ss_s,b) and representation states (srs_s,b). In correlation, it activates the body loops related to the feelings
of the victim, i.e. feeling of anger (fsang: green; psang: light blue), feeling of threat (fsth: blue; psth: brown) and feeling of sadness (fssd: green; pssd: purple). Moreover, the self-awareness/ownership states (pos: light orange, ros: cyan) also gets activated around time point \( t = 10 \). However, as the feelings of sadness are low (0.03 at \( t = 60 \)), the avoidance response is not activated (psavd:magenta; esavd:red) and thus, stays low (Figure 4).

4.2. Role of the mediator in comforting the victim

The literature shows that parents, supervisors or teachers can act as a mediator, and can play an important role to comfort the victim (Elliott, 2002). In this section, we will present two scenarios that will address, i.e. (a) how a mediator listens and reacts to a situation and (b) how a mediator can influence a bullying victim.

4.2.1. A mediator listening to the peers: victim and his/her bully

Consider an initiation scenario of telling a mediator like ‘if you call my son a bully, I’ll go straight to the principal and tell that’ (Sondergaard, 2012).

In order to make a rational decision among a bully and its victim, the mediator listens to both of the persons, thus the input of the model starts with input from bully and victim. For example, here son is the victim (as people call him bully and may be his parent wants to inform that he is not) of the subject ‘you’. So, a mediator (the principal) will have input from the aggressor and victim (wsb, wsv = yellow, value = 1). The respective sensory states (ssb = ss = deep blue) are activated, which further activates the respective sensory representation states (srssb = srs = greyish blue), increasing the belief state (bs = purple till 0.6). This helps him to decide through, evaluation (eval = orange till 0.6) and thinking rationally by the cortex (PFC = cyan till 0.6) at time point \( t \approx 10 \). As a result, the mediator tends to have an action over the situation (an example can be dealing with the two parties as per law) activating respective states high (psact = green; esact = red with asterisks). This anti-bullying action of mediator (psact,esact) is correlated with the feelings of empathy (fsemp = blue; psemp = dotted blue), power (fspow = green; pspow = dotted green) and trust (fstrust = bright green; pstrust = bright green dotted; and estrust = black) (Figure 5).
4.2.2. Mediator’s influence over bullying victim

As the focus of the paper is the bullying victim, therefore, we only simulated how the mediator influences the victim. This scenario is related to influence a bullying victim through his feelings associated with avoiding or approaching the bully. The main role of a mediator is to help the victim to let the negative feelings fade away and to make the victim realize that he is not alone. An example scenario could be the following ‘One mum successfully helped her son to break the cycle by inviting two of the boys and their families around for a barbecue’ (Elliott, 2002). This indicates that a mediator (parent) can open a channel for discussion for the kids if they were bullied and, other parents can also be involved to resolve the matter.

The simulation of this example scenario is shown in the form of episodes. The first episode consists of two possible reactions (either approach or avoid) of the victim, which are discussed earlier. The second episode consists of the encounter of the victim with his mediator. The second episode starts near time point $t = 100$, when $w_{med}$ and $e_{trust} = 1$. The trust developed from this interaction helps to make his belief state high ($bs =$ light brown dotted). The belief state activates the related states: courage ($f_{scou}$, $p_{scou}$, $e_{scou} =$ shades of blue – dotted), self-respect ($f_{sres}$, $p_{sres}$, $e_{sres} =$ shades of green – dotted) and not feeling alone ($f_{snal}$, $p_{snal}$, $e_{snal} =$ shades of purple – dotted). Once they are activated, they suppress the negative feelings associated with the reaction of the bully.

Figures 6 and 7 show the suppression of feelings (shown by the bold asterisk) associated with the avoid ($f_{sth}$, $f_{ssd}$ and $f_{srej}$) or the approach reaction ($f_{sth}$,$f_{sad}$). In the avoidance reaction, it can be seen that the avoidance response is also lowered. This is the causal impact of suppressed negative feelings. However, this can’t be observed in the approach reaction, since the victim approaches the bully on the basis of reactive anger ($f_{sad}$), which is usually situational.

5. Parameter tuning

To tune any model according to the real world, empirical data are always appreciated. However, finding numerical empirical data that can reflect the dynamics of human
behaviour against their social, cognitive and psychological aspects is a challenging task. The reason is that the data need to be collected for all of the states in a scenario (a) in terms of relatedness and causality and (b) with the regular intervals of time (Malinsky & Danks, 2018). However, as there is extensive literature available, it can be helpful to reveal the causal relationship between processes/states of any scenario by their use-cases (Sibertin-Blanc, Tahir, & Cardoso, 2005). We used the literature addressed in Table 3, to synthesize the numerical data for some of the states of the model. We extracted seven states from the victim model for this purpose. These states address the scenario of a victim approaching his/her bully, i.e. ssb, srsb, cs, fsr, fsa, pSapp and esapp.

We provided the literature to the subject matter experts, who were able to deduce the expected patterns for the scenario. The extracted patterns were used to produce numerical data consisting of 10 data points. Later on, we applied the cubic interpolation

Figure 6. Mediator’s influence over a bullying victim during the avoidance reaction.

Figure 7. Mediator’s influence over a bullying victim during the approach reaction.
technique to produce 500 data points for each of the states. Figure 8 (dotted) shows the interpolated data. These empirical data can be used to tune different parameters in order to find an optimal solution that reflects closeness between the simulated and the empirically driven model. This technique is called ‘parameter tuning’.

First, in order to make the model correspondence as close as possible, we used the error function called ‘root mean-squared error’ (RMSE), where lesser values indicate more closeness between the models. Second, we used simulated annealing (SA) as the optimization algorithm. Many optimization algorithms related to probability, or genetic algorithms are available and can be used to achieve optimization of the error function. However, among them, SA is considered to be a good choice, as it has increased the likelihood of finding global optima (Binitha & Siva Sathya, 2012; Kirkpatrick, Gelatt, & Vecchi, 1983). In other words, this probabilistic technique attempts to minimize the error by navigating a different set of values in the model space to find a global minima for the function. We used SA in order to tune the speed factors ‘$\eta_Y$’ of the discussed states. The acceptable solution was received after 3601 iterations with RMSE = ‘0.17’, which indicates

### Table 3. Empirical literature to synthesize data.

| Empirical literature                                                                 | Deduced simulation pattern                                                                                                                                 |
|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stimulus triggers emotion (Damasio, 2010)                                            | A victim gets the stimulus and thus: $w_{ss} = 1$. This activates $ss$, $ss_b$, and $srs_{ss,b}$. Mostly the feelings of anger, threat and a little sadness would make the victim to approach and react to bullying. The feeling states gradually become active and lead to different outcomes, based on the scenario. As the Control state $cs$ gets high, it suppresses the negative feeling of anger ($f_{sang}$), threat ($f_{sth}$), sadness ($f_{ssd}$), and rejection ($f_{srej}$), and prevents them from rising further. Preparation states for avoid and approach $ps_{savd}$ and $ps_{appro}$ are activated along with the emotions (feelings and respective preparation states, like $f_{sang}$ and $ps_{sang}$). Prior ownership state is involved in owning the ‘approach’ reaction of the victim which is an aggressive outcome (feeling of angry in this case). The retrospective ownership state would own the reaction after the execution of approach action ($es_{sapp}$). |
| Emotions expression through different means (Erişti & Akbulut, 2019; Gíménez Gualdo et al., 2015) |                                                                                                                                                             |
| Feelings fear, sad, angry, rejected are perceived as negative feelings that are suppressed (Diener et al., 2010; Ortega et al., 2012) |                                                                                                                                                             |
| Different emotions lead to different responses (Bellmore, Chen, & Rischall, 2013; Camodeca & Goossens, 2005; Sandstrom 2004) |                                                                                                                                                             |
| Inferential processes influence conscious awareness of operant action (Moore & Haggard, 2008) |                                                                                                                                                             |

![Figure 8. Simulation results with tuned parameter values of ‘$\eta_Y$’, and empirical data.](image-url)
well tuning of the parameter values for each of the chosen states, shown in Table 4. Figure 8 shows the difference between the empirical and the simulated curves with tuned parameters.

6. Mathematical analysis

Simulation experiments reflect the dynamic properties of a model and it can be verified through related empirical data as well as by using analytical means. For example, there are few known analytical properties like equilibrium, monotonicity or limit cycle, that can be used to verify a model. Equilibrium is related to the convergence of the whole model with no further dynamics, whereas the other two properties are related to states of a model. Monotonicity is related to increasing or decreasing behaviour, while the limit cycle is the repetition of value, of a state over time without gaining equilibrium. These properties take the form of equations or inequalities for the states (Treur, 2016), and can be compared at certain time points with simulation experiments to verify the model. In this section, we used the property of ‘equilibrium’ to verify our model.

As discussed earlier, a model is considered to be in equilibrium, if it doesn’t show any dynamic behaviour after a certain period of time. In other words, if all states don’t change at time \( t \) (and have stationary points or \( dY(t)/dt = 0 \)), then the model is at equilibrium. Therefore by using equation (2) and assuming the speed factor nonzero we have

\[
\text{aggimpact}_y(t) - Y(t) = 0 \iff Y(t) = c_y(\omega_{X_1}Y_1(t), \ldots, \omega_{X_k}Y_k(t))
\]  

(4)

We performed an analysis of the scenario in which a victim chooses to approach the bully. In this scenario, the states which activate the avoidance behaviour remain low, while the states which are correlated with the approach scenario show their dynamics over the time. However, it can be seen in Figure 9 that the model starts to converge (stationary points) around time point \( t = 60 \). For instance, most of the state are converged in the duration of \( t = 50–150 \), except the feeling of threat (\( f_{sth},p_{sth} \)). Equation (4) is used to compute the deviations of each state (\( Y \)) between the simulation of the tuned model (Figure 9), and the analytical result (aggImpact) of the model. The difference between the simulation values and the linear equations is computed by WIMS\(^1\) linear solver, which shows deviations are not more than 0.02 (presented in Table 5).

Table 4. Speed factor values after tuning.

| State       | ss\(_b\) | srs\(_{s,b}\) | cs | p\(_{app}\) | e\(_{app}\) | f\(_s\) | f\(_{sa}\) |
|-------------|---------|----------------|----|-----------|-----------|-------|--------|
| Speed factor (\(\eta\)) | 0.0394  | 0.362          | 0.264 | 0.173     | 0.516     | 0.0443 | 0.007  |

Equations used to perform the mathematical analysis are:

| Equation (1) | \( w_{ss} = 1 \) | Equation (11) | \( p_{sapp} = 0.7 \ast f_{sapp} \) |
|--------------|-----------------|---------------|-----------------------------------|
| Equation (2) | \( e_{sb} = 1 \) | Equation (12) | \( f_{sth} = 0.9961081 \) |
| Equation (3) | \( 1.6 \ast ss_{sb} = 0.8 \ast es_{sb} + 0.8 \ast ws_{s} \) | Equation (13) | \( p_{sth} = 0.7 \ast f_{sth} \) |
| Equation (4) | \( rs_{s,b} = 0.9 \ast ss_{s,b} \) | Equation (14) | \( p_{sd} = 0.000832 \) |
| Equation (5) | \( cs = 1 \) | Equation (15) | \( p_{sd} = 0.8 \ast f_{sd} \) |
| Equation (6) | \( p_{sapp} = 0.999846 \) | Equation (16) | \( f_{srej} = 0 \) |
| Equation (7) | \( p_{os} = 0.8 \ast p_{sapp} \) | Equation (17) | \( p_{srej} = 0.6 \ast f_{srej} \) |
| Equation (8) | \( ros = 1 \ast pos \) | Equation (18) | \( p_{svd} = 0.000274 \) |
| Equation (9) | \( 1.8 \ast e_{sapp} = 1 \ast p_{sapp} + 0.8 \ast ros \) | Equation (19) | \( e_{svd} = 0.8 \ast p_{svd} \) |
| Equation (10) | \( f_{sang} = 0.998327 \) | Equation (20) | \( sss_{sb} = 0.8 \ast e_{sapp} \) |
7. Data analysis and relevance for the models

Model validation with respect to publically available data sets is a not very easy, usually because: (a) these models are temporal and (b) they show their dynamics in different social, cognitive and psychological aspects. However, such datasets can be used to get an overall impression with respect to the model, once it achieves equilibrium. In this section, we analysed a real-world dataset of 15,425 students (9–12 grades) collected by ‘Youth Risk Behavior Surveillance System’ in the year 2011 (‘YRBS - 2011’, n.d.).

We performed data analysis for approach (fights > 0) or avoid (fights = 0) reactions of the victim. Data were pre-processed by removing the records with blank entries, so we were left with 11,811 records. First, we observed that 8361 (male: 4402; female:3959) victims didn’t set a complaint about their bully, while 3440 (male: 1448; female:1992) reported to their teacher about being bullied, rest 10 students didn’t reply to this question. However, the data don’t inform us any aftermaths of mediator counselling.

Second, we categorized the 11,811 records into students with: (a) school bullying (SBVictims = 1087 victims), (b) cyberbullying (CBVictims = 796), (c) both (CSBVictims = 1026) for the model. Among each category, we sub-categorized victims (by applying data filters), into four sub-categories: (i) the victims who felt threat and sadness (TH&SAD), (ii) not any of threat or sadness (= NONE), (iii) only sadness (SAD) and (iv)
only threat (=TH). In Figure 7, stacked plot represents approach/avoid reactions (dark and light blue, respectively) between the three categories of bullying victims. On the one side, it can be seen that people feeling threat (TH;TH&SAD) tend to approach (as approach > avoid), as addressed in the literature (Resseguier, Léger, Sénécal, Bastarache-Roberge, & Courtemanche, 2016). However, it is not obvious from the data how high the feeling of threat or sadness within a victim precisely is to make a decision. While on the other side, victims with no addressed feeling or the feeling of sadness (NONE;SAD) are more inclined to the avoid reaction (avoid > approach) (Figure 10).

Here, we may infer from the available data that the person, who feels threat from their bully, is more inclined to approach and the person who feels sad tends to avoid his/her bully. This is what we observed during the simulation experiments as well (Figures 3 and 4). For example, consider figure 4, the person chooses the approach strategy (time point $t \geq 10$) while feeling threat (TH) and sadness (SAD). These data are useful to compare to the model at equilibrium, but it has few limitations. Here, only two feelings ($f_{sth}, f_{sad}$) are indicated, while our model addresses at least four related feelings. Moreover, it is not very clear what the feelings were before or after the reaction of the victims. Further, the teacher (mediator) and his interaction with the victim are not incorporated in the data set. In order to get more insights, data that reflect the cognitive and behavioural aspects of both of the models with temporal-causal dynamics would be needed.

8. Conclusion

Our work aims to address the behaviour of a bullying victim, with respect to cognitive and social literature. To achieve this, two temporal-causal models were designed: (a) bullying victim and his (b) mediator. The models were simulated in order to understand
(a) how a victim avoids a bully or (b) how he approaches a bully. Further, we also simulated (c) how a mediator listens to both: victim and his bully, and which feelings are involved in order to make a decision of action. Moreover, it was also observed (d) which factors and feelings are initiated when a mediator discusses the bullying situation with its victim. During simulations, on the one hand, it was observed that mainly the feelings of anger and threat caused the victim to approach the bully, and, on the other hand, feelings of rejection from society, sadness and threat cause the victim to avoid the bully. As a mediator is intended to support a victim to be ‘not a victim’, so as soon as a victim discusses his situation with his mediator, his negative feelings of threat, sadness and rejection are suppressed. The reason is the feeling of trust, which encourages him and he has a feeling of self-respect and gets a feeling that he is not rejected from society.

The victim model was tuned against empirical data generated by subject matter experts, to make the model work close to the real-world scenarios of victimization. The tuned victim model was verified analytically, and it was observed that the model is working as was expected. Behaviour of the model of the victim, regarding feelings of threat and sadness was also compared with a publically available data set. This comparison was made when the model was at equilibrium and it shows that mostly victims choose the approach strategy when they feel a threat from their bullies and avoid them otherwise.

As a future work, we aim to incorporate the reaction of the victim in repetitive episodes of bullying, so that we can study the influence of mediator before and after the mediation. Moreover, we would like to see the influence of a mediator over a bully and how anti-bullying strategies work. Lastly, we would like to compare the model with temporal-causal data which should be collected in the context of states which were derived under the cognitive, social and behavioural literature.

Note
1. http://wims.unice.fr/wims/wims.cgi

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Notes on contributors
Fakhra Jabeen is a PhD student in the Social AI Group, Vrije Universiteit Amsterdam. Her main research interests are exploring negative aspects of social media and to provide support to peers who are affected.

Nizar A. Hirzalla is a master’s student in artificial intelligence.

Thomas M. Maaiveld is a master’s student in artificial intelligence.
Dr Charlotte Gerritsen is an assistant professor in Social AI at the Vrije Universiteit Amsterdam. Her research mainly focuses on the interplay between AI and Criminology with an emphasis on negative emotions.

Prof. Dr Jan Treur is a full professor of AI in the Social AI Group. His main focus is on adaptive network modelling for mental and social processes.

ORCID

Fakhra Jabeen http://orcid.org/0000-0002-1954-8522

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