Deliberate Self-harm: a study about the evolution of stable maladaptive strategies

Cristina Cecchini[1], Patrizia Meringolo[2], and Andrea Guazzini[3]

[1] Department of Information Engineering and CSDC, Università di Firenze (Italy), cristina.cecchini@unifi.it,
[2] Department of Education and Psychology and CSDC, Università di Firenze (Italy), patrizia.meringolo@unifi.it
[3] Department of Education and Psychology and CSDC, Università di Firenze (Italy), andrea.guazzini@unifi.it

Abstract. Self-injury is a maladaptive behavior described as the intentional injuring of one's own body without suicidal intent, and it is very common in adolescents. The Experiential Avoidance model claims it is a negatively reinforced strategy for terminating unwanted emotional arousal, which reveals complex dynamics. Literature has not revealed the role of diverse factors in affecting such a behavior. The aim of this study is to model dynamics of self-injury in adolescence, through an agent based modelling (ABM) approach, by focusing on network topologies (i.e., Uniform, Gaussian, Exponential), three main categories of risk factors (i.e., Inner Factors, Outer Factors, Media Factors), and the interaction between nodes. A probability to experience stressful events is fixed, and the final number of self-injurious agents is the order parameter. Results are expected to show the combine effect of risk factors and topology, highlighting interesting scenarios about the complex dynamics of the phenomenon.

Keywords: Self-injury; Risk behavior; Computational modeling; Nonlinear dynamics; Complex system

1 Introduction

Self-injury has been defined by the International Society for the Study of Self-Injury as "the deliberate, self-inflicted destruction of body tissue without suicidal intent" [1], where a definite intention to die discriminates a suicide attempt from such a behavior. It is also defined as Deliberate Self-Harm (DSH) and Non-Suicidal Self-Injury (NSSI). The set of behaviors consistently changes, depending on the severity of the injury, the repetitiveness and pattern of behaviors. It appears to be a maladaptive coping strategy, unlike a real purpose to die. A clear discrimination between the two behaviors is problematic, since several research stated that the suicidal intent is difficult to recognize [2]. However, the high comorbidity between self-injury and suicidal behaviors, as well as the increased suicide risk for people with self-injuy history, highlights the seriousness of the behavior [3]. A relevant theoretical model is the Experiential Avoidance Model, which asserts that self-injury is a negatively reinforced strategy to reduce or end an unwanted emotional arousal, and it involves any behavior suitable to avoid eliciting stressful internal and external experiences (e.g. thoughts) [4]. The model highlighted the cyclical and complex dynamics, and the role of several factors affecting the behavior. Indeed, the integrated theoretical model of the development and maintenance of self-injury analyzed such dimensions. The model states that some distal factors (e.g., childhood abuse) increase the risk of engaging in self-injurious behaviors by interacting with intrapersonal and interpersonal factors (e.g., poor communication skills). Moreover, several specific factors (e.g. self-punishment) may interfere with the affect regulation of people, producing a stress response, which may elicit self-injury [5]. Again, such a model underlines the complex nature of self-injury, and the high number of factors affecting it. Unfortunately, any research has yet shown the role of diverse factors in impacting such a behavior. This study purposes to explore this aspect by the implementation of an agent based model of self-injury in adolescents.

1.1 Aims of the study

The study aims to model the self-injurious behaviors in adolescence, through an agent based modelling (ABM) approach. In particular, we focused on the influence of the social network on self-injury, and we took into account three different topologies of the network (i.e., Uniform, Gaussian, Exponential) as first factor. Moreover, as previous studies showed the influence of various factors in increasing such a behavior, three main categories of risk factors (i.e., Inner Factors, Outer Factors, Media Factors) were chosen from literature. Finally, the influence of self-injurious nodes (i.e., Peer Factor) was contemplated as a dynamics parameter. Furthermore, a probability to experience stressful events was considered as a fixed parameter (0.1), adopting a conservative decision to avoid bias in the model. The order parameters were the final numbers of self-harmer agents, and the interaction between nodes with different states.

Except for the topology factor, we assumed that all the factors contributed directly to the dynamics system.

2 Method

2.1 The model

All the factors composing the model are described.

The fist factor (A) is the Topology of the Network, which is characterized by Gaussian, Exponential or Uniform distribution of the nodes' degree (k_i). A Montecarlo method was implemented for the network structure. Each distribution is described through an equation revealing the process through which an agent i is connected with an agent j, so to produce an overall distribution of the variable k_i. A directed adjacency matrix was adopted to represent the social network. In the Uniform Network, for each node i, a random number was extracted $r \in (1, 1)$ from a uniform distribution, which is the degree K_i of the subject i:

$$K_i = floor((rand * (N - 1)) + 1) \quad (1)$$

In the Gaussian Network, for each node i, and for each different node j, a random number was extracted $r \in (0, 1)$ from a uniform distribution, and we approximated it to the nearest integer $\in (0, 1)$. Then, a link between i and j was settled when the resulting number was 1.

$$L_{ij} = floor((rand * N) + 1) \quad (2)$$

In the Exponential Network, for each node i, a random number was extracted $r \in (1, < N)$ from a uniform distribution. Such a number was accepted to be the degree of the node i with a probability that scaled with the exponential of the integer proposed.

$$r_i = floor((rand * N) + 1) \quad (3)$$

$$P_{K_i} = \exp(-r_i) \quad (4)$$

If another random number extracted was smaller of P_{K_i}, the degree of i was accepted, on the contrary another uniformly distributed number was extracted $\in (1, N)$.

The second factor is the Inner Factor (IF), consisting of psychological, and biological features that increase or mediate the vulnerability to engage in self-injury. It includes the following variables selected by recent literature [5–18]: being female; poor self esteem, problem-solving and coping strategies; poor body image; impulsivity; self-criticism; uncertain sex orientation; anxiety; trouble sleeping at 12-14 years old; internalizing and externalizing problems; negative affect and cognitive style; lower pain sensitivity; excessive reassurance seeking; desire to see blood; sexual abuse.

It is modelled as a continuous parameter $IF_i \in (0, 1)$, that modulates the risk factors introduced by the inner factors, following a gaussian distribution with the parameters equal to $Mean = \beta_1$, and $Sd = \beta_2$. It is represented by means of the control parameter β_0, which is 25%.

$$IF_i = (randn * \beta_2) + \beta_1 \quad (5)$$

A weight of the Inner Factor (wIF_i) was obtained by means of the equation 6:

$$wIF_i = 0.25 * IF \quad (6)$$

The third factor is the Outer Factor (OF), consisting of people affecting the node's (individual) behavior, such as family, teachers, and other significant people. Particularly, we selected the following variables from literature [10, 13, 14, 18–21]: a general poor relationship quality; poor family support; parental criticism; mother mental illness and paternal depression; non-intact family at age 12. Peers are considered in the Peer Factor (PF). It is modelled as a continuous parameter $OF_i \in (0,1)$, that modulates the risk factors introduced by the outer factors, following a gaussian distribution with the parameters equal to $Mean = \gamma_1$, and $Sd = \gamma_2$. It is represented by means of the control parameter γ_0, which is 25%.

$$OF_i = (randn * \gamma_2) + \gamma_1 \tag{7}$$

A weigth of the Outer Factor (wOF_i) was obtained by means of the equation 8:

$$wOF_i = 0.25 * OF \tag{8}$$

The forth factor is the Media Factor (MF), stating the influence of media, such as tv, internet, and newspapers, according to specific literature [22–32]. It is modelled as a continuous parameter $MF_i \in (0,1)$ that modulates the risk factors introduced by the media factors, , following a gaussian distribution with the parameters equal to $Mean = \delta_1$, and $Sd = \delta_2$. It is represented by means of the control parameter δ_0, which is 25%.

$$MF_i = (randn * \delta_2) + \delta_1 \tag{9}$$

A weight of the Media Factor (wMF_i) by means of the equation 10:

$$wMF_i = 0.25 * MF \tag{10}$$

Moreover, the probability to experience bad/stressing events in the life was defined, as well as the fifth factor Peer Factor (E), both ranging within the interval $(0,1)$, in order to seed the dynamics. The Peer Factor (PF_i) is defined as the density of self-injurious nodes in the network, and it is represented by means of the control parameter ϵ_0, which is 25%.

Finally, an Harm vector is stored as well, containing for each node and for each time step if the node produced an injury, as a result of the model dynamics.

Then, we proceeded to the numerical simulation of the system, according to the equation 11 which attests the probability of injury:

$$PI_i^t = IF_i * \beta_0 + OF_i * \gamma_0 + MF_i * \delta_0 + PF_i^t * \epsilon_0 \tag{11}$$

3 Preliminary results

Results shown the effect of risk factors on the number of self-injurious nodes in the network, while little effect of the topology is displayed. Particularly, the Peer Factor (PF) interacts with other considered Factors (IF, OF, MF) to modify the network. As we decided to analyze each factor individually, figure 1 shows the effect of Inner Factor on the number of self-harmers in the network. The percentage of the Inner Factor is illustrated on the horizontal axis, and the

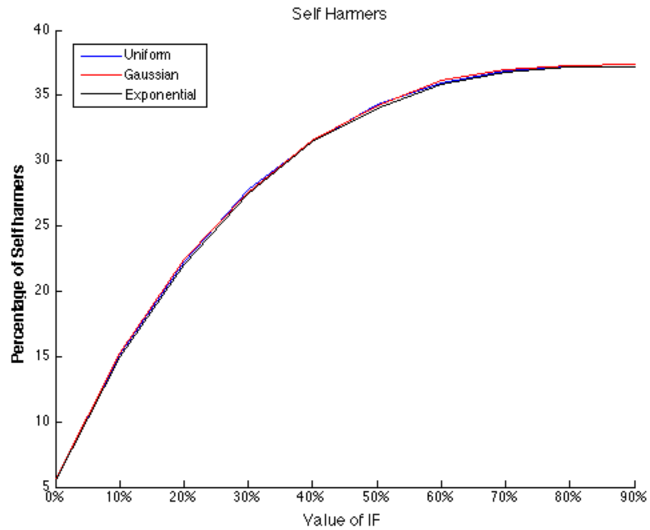

Fig. 1. Inner Factor effect

percentage of self-harmers is shown on the vertical axis. As the Inner Factor increases, the number of self-harmers tend to grow until the 35% of total nodes in the network. Uniform, Gaussian and Exponential networks display the same trend, apparently revealing any effect on the network.

In figure 2 the effect of self-injurious nodes on the network is shown. The percentage of the Peer Factor is illustrated on the horizontal axis, and the percentage of self-harmers is shown on the vertical axis. As the risk factor IF increases, PF increases as well, and the number of self-harmers grows until the 35% of the total nodes. Again, an effect of the topology is not revealed.

4 Conclusions

These results highlight interesting scenarios about the complex dynamics of the phenomenon.

As a data collection about risk behaviors and self-injury was conducted among adolescents, real data obtained by such a survey will be implemented in the dataset, and all factors considered will be weighed.

Once validated, the model could be applied to other maladaptive behaviors, such as gambling addiction, to better understanding them.

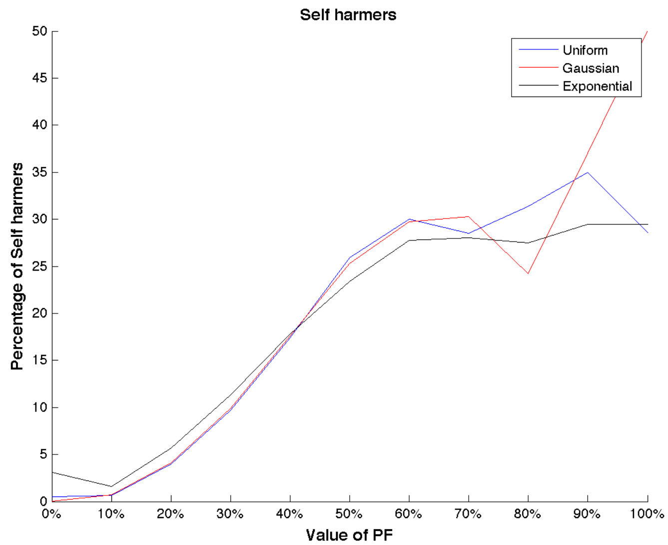

Fig. 2. Peer Factor effect

References

1. International Society for the Study of Self-injury.: Definitional issues surrounding our understanding of self-injury. Conference proceedings from the annual meeting. (2007)
2. Dickstein, D. P., Puzia, M. E., Cushman, G. K., Weissman, A. B., Wegbreit, E., Kim, K. L., Nock, M. K., Spirito, A.: Self-injurious implicit attitudes among adolescent suicide attempters versus those engaged in nonsuicidal self-injury. Journal of child psychology and psychiatry. 56(10), 1127–1136 (2015)
3. Whitlock, J., Knox, K. L.: The relationship between self-injurious behavior and suicide in a young adult population. Arch Pediatr Adolesc Med. 161, 634-–40 (2007)
4. Chapman, A. L., Gratz, K. L., Brown, M. Z.: Solving the puzzle of deliberate self-harm: The experiential avoidance model. Behaviour research and therapy. 44(3), 371–394 (2006)
5. Nock, M. K.: Self-injury. Annual review of clinical psychology. 6, 339–363 (2010)
6. You, J., Lin, M. P., Leung, F.: A longitudinal moderated mediation model of non-suicidal self-injury among adolescents. Journal of abnormal child psychology, 43(2), 381–390 (2015)
7. O'Connor, R. C., Rasmussen, S., Hawton, K.: Predicting deliberate self-harm in adolescents: a six month prospective study. Suicide and Life-Threatening Behavior, 39(4), 364–375 (2009)
8. Tait, R. J., Brinker, J., Moller, C. I., French, D. J.: Rumination, substance use, and self-harm in a representative Australian adult sample. Journal of clinical psychology, 70(3), 283-293 (2014)

9. Wong, M. M., Brower, K. J., Zucker, R. A.: Sleep problems, suicidal ideation, and self-harm behaviors in adolescence. Journal of psychiatric research, 45(4), 505–511 (2011)
10. Sourander, A., Aromaa, M., Pihlakoski, L., Haavisto, A., Rautava, P., Helenius, H., Sillanpää, M.: Early predictors of deliberate self-harm among adolescents. A prospective follow-up study from age 3 to age 15. Journal of affective disorders, 93(1), 87–96 (2006)
11. Shin, Y. M., Chung, Y. K., Lim, K. Y., Lee, Y. M., Oh, E. Y., Cho, S. M.: Childhood predictors of deliberate self-harm behavior and suicide ideation in Korean adolescents: a prospective population-based follow-up study. Journal of Korean medical science, 24(2), 215–222 (2009)
12. Wang, A. W. T., Hsu, W. Y.: Applying the Tripartite Model to the Link between Non-Suicidal Self-Injury and Suicidal Risk. Chinese Journal of Psychology, 57(4), 303–318 (2015)
13. Hankin, B. L., Abela, J. R.: Nonsuicidal self-injury in adolescence: Prospective rates and risk factors in a 2 and half year longitudinal study. Psychiatry Research, 186(1), 65–70 (2011)
14. Tschan, T., Schmid, M., In-Albon, T.: Parenting behavior in families of female adolescents with nonsuicidal self-injury in comparison to a clinical and a nonclinical control group. Child and adolescent psychiatry and mental health, 9(1), 1 (2015)
15. Glenn, C. R., Klonsky, E. D.: The Role of seeing blood in non-suicidal self-injury. Journal of clinical psychology, 66(4), 466–473 (2010)
16. Duggan, J., Heath, N., Hu, T.: Non-suicidal self-injury maintenance and cessation among adolescents: a one-year longitudinal investigation of the role of objectified body consciousness, depression and emotion dysregulation. Child and adolescent psychiatry and mental health, 9(1), 1 (2015)
17. Muehlenkamp, J. J., Brausch, A. M.: Body image as a mediator of non-suicidal self-injury in adolescents. Journal of adolescence, 35(1), 1–9 (2012)
18. Andrews, T., Martin, G., Hasking, P., Page, A.: Predictors of onset for non-suicidal self-injury within a school-based sample of adolescents. Prevention Science, 15(6), 850-859 (2014)
19. Hilt, L. M., Nock, M. K., Lloyd-Richardson, E. E., Prinstein, M. J.: Longitudinal study of nonsuicidal self-injury among young adolescents rates, correlates, and preliminary test of an interpersonal model. The Journal of Early Adolescence, 28(3), 455–469 (2008)
20. Yates, T. M., Tracy, A. J., Luthar, S. S.: Nonsuicidal self-injury among" privileged" youths: longitudinal and cross-sectional approaches to developmental process. Journal of consulting and clinical psychology, 76(1), 52 (2008)
21. Wilcox, H. C., Arria, A. M., Caldeira, K. M., Vincent, K. B., Pinchevsky, G. M., O'Grady, K. E.: Longitudinal predictors of past-year non-suicidal self-injury and motives among college students. Psychological medicine, 42(04), 717–726 (2012)
22. Harris, I. M., Roberts, L. M.: Exploring the use and effects of deliberate self-harm websites: An internet-based study. Journal of Medical Internet Research, 15(12), e285–e285 (2013)
23. Whitlock, J. L., Powers, J. L., Eckenrode, J.: The virtual cutting edge: the internet and adolescent self-injury. Developmental psychology, 42(3), 407 (2006)
24. Messina, E. S., Iwasaki, Y.: Internet use and self-injurious behaviors among adolescents and young adults: An interdisciplinary literature review and implications for health professionals. Cyberpsychology, Behavior, and Social Networking, 14(3), 161–168 (2011)

25. Mars, B., Heron, J., Biddle, L., Donovan, J. L., Holley, R., Piper, M., ... Gunnell, D.: Exposure to, and searching for, information about suicide and self-harm on the Internet: Prevalence and predictors in a population based cohort of young adults. Journal of Affective Disorders, 185, 239–245 (2015)
26. Mitchell, K. J., Wells, M., Priebe, G., Ybarra, M. L.: Exposure to websites that encourage self-harm and suicide: Prevalence rates and association with actual thoughts of self-harm and thoughts of suicide in the United States. Journal of adolescence, 37(8), 1335–1344 (2014)
27. Lewis, S. P., Baker, T. G.: The possible risks of self-injury web sites: a content analysis. Archives of suicide research, 15(4), 390–396 (2011)
28. Lewis, S. P., Heath, N. L., St Denis, J. M., Noble, R.: The scope of nonsuicidal self-injury on YouTube. Pediatrics, 127(3), e552–e557 (2011)
29. Daine, K., Hawton, K., Singaravelu, V., Stewart, A., Simkin, S., Montgomery, P.: The power of the web: a systematic review of studies of the influence of the internet on self-harm and suicide in young people. PloS one, 8(10), e77555 (2013)
30. Zahl, D. L., Hawton, K.: Media influences on suicidal behaviour: an interview study of young people. Behavioural and Cognitive Psychotherapy, 32(02), 189–198 (2004)
31. Martin, G.: The influence of television suicide in a normal adolescent population. Archives of Suicide Research, 2(2), 103–117 (1996)
32. Whitlock, J., Purington, A., Gershkovich, M.: Media, the Internet, and nonsuicidal self-injury. (2009)