Rescue Model for the Bystanders' Intervention in Emergencies

(physics/0509095)

Hang-Hyun Jo*, Woo-Sung Jung, and Hie-Tae Moon

Dept. of Physics, KAIST, Korea / Sep. 20, 2005

(* kyauou2@kaist.ac.kr)

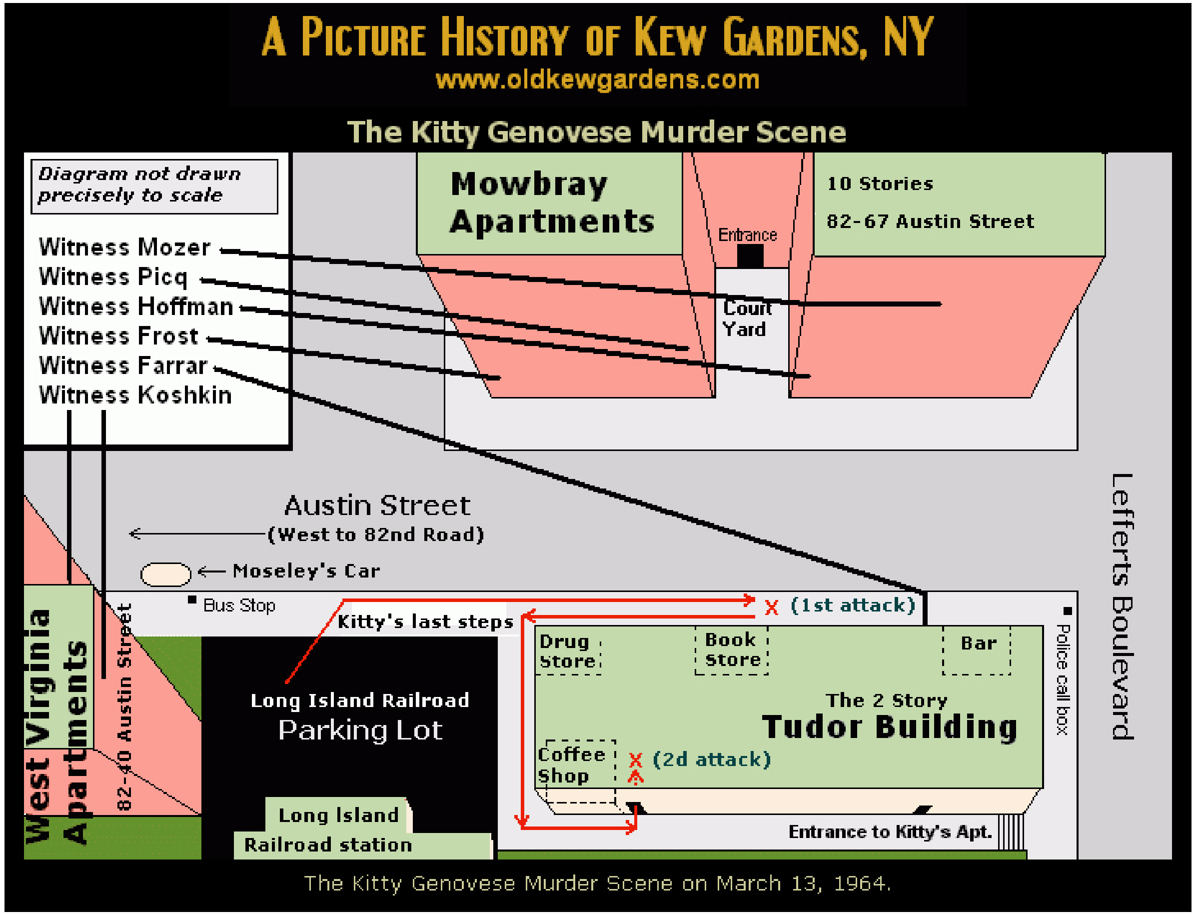
Kitty Genovese Case (1)

- March 27, 1964 *New York Times*: "37 Who Saw Murder Didn't Call the Police." (38 witnesses in the article)
- This murder created a sensation.

Kitty Genovese Case (2)

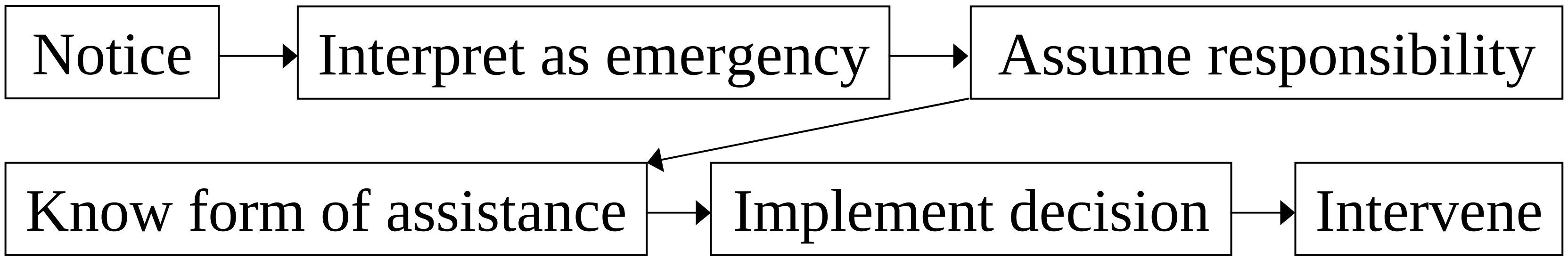
- The popular account of the murder is mostly wrong!

(J. De May, http://www.oldkewgardens.com/ss-nytimes



Bystander Effect

- People are less likely to intervene in emergencies when they are with other people than when they are alone.
- B. Latané and J. Darley (1969, 1970)



- Recognition: The presence of other people may affect the interpretations of bystanders.

- Action: Because of diffusion of responsibility each may feel less necessity to help.

Experiment (1): Smoke in the room

- How do subjects react to the puffed smoke in a room?
- Response rates (reporting the smoke)

  (a) alone subjects: 75%

  (b) subjects with two passive confederates: 10%

  (c) subjects with two other subjects: 38%

  $< 98\% = 1-(1-0.75)^3$
- Other bystanders inhibit the intervention.

Experiment (2): A fit to be tried

- How fast do subjects react to the victim's fit?
- Response rates (reporting the victim's seizure)

  (a) subjects in 2-person condition: 100%

  (b) subjects in 6-person condition: 62%
- Two friends responded faster than other 3-person groups.

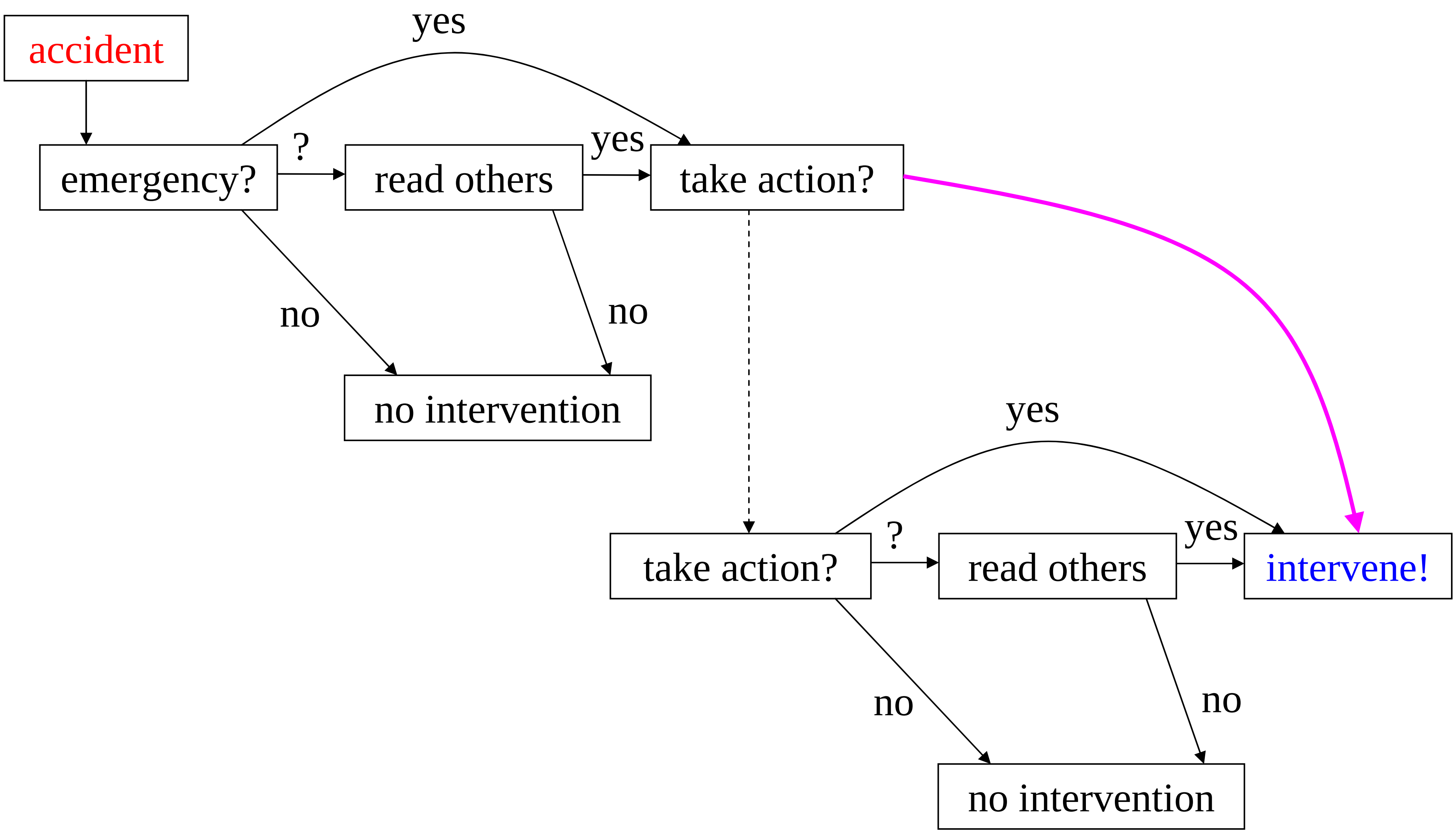
  → Responsibility doesn't diffuse across friends.
- Subjects who had met the victim responded faster than the others.

Aftermath of Bystander Effect

- Social impact theory (Latané 1981)
- Arousal: Cost-Reward Model (Piliavin *et al*. 1982)
- Statistical mechanics of social impact (Nowak *et al*. 1990; Lewenstein *et al*. 1992)
- Opinion dynamics (Hołyst *et al*. 2000, 2001, Stauffer 2005)

We introduce a model describing bystander effect itself.

Rescue Model (1)



Rescue Model (2)

- Relation spin: $a_{ij} = 1 \text{ or } 0$

  $\rightarrow$ adjacency matrix of helping network
- Choose a victim v, # of bystanders k_v and bystanders N_v.
- Update rule:

accident, drawn from [0,1] randomly

$$a_{vi}(t+1) = \theta\left(\underbrace{q_v + \alpha a_{vi}(t) + \beta \sum_{j \in N_v,\, j \neq i} (2a_{ij}(t) - 1) - c_i}_{x_i} \right)$$

victim's acquaintance with bystander

threshold over which agent i intervenes

acquaintance among bystanders

Rescue Model (3)

- Control parameters

  - c_i : intervention threshold, fixed as 0.25 for all i.

  - α: acquaintance strength, fixed as 0.1.

  - β: coupling strength

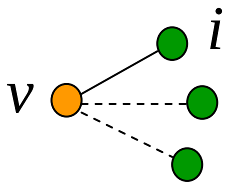
  - k : the number of bystanders, [1,N-1]

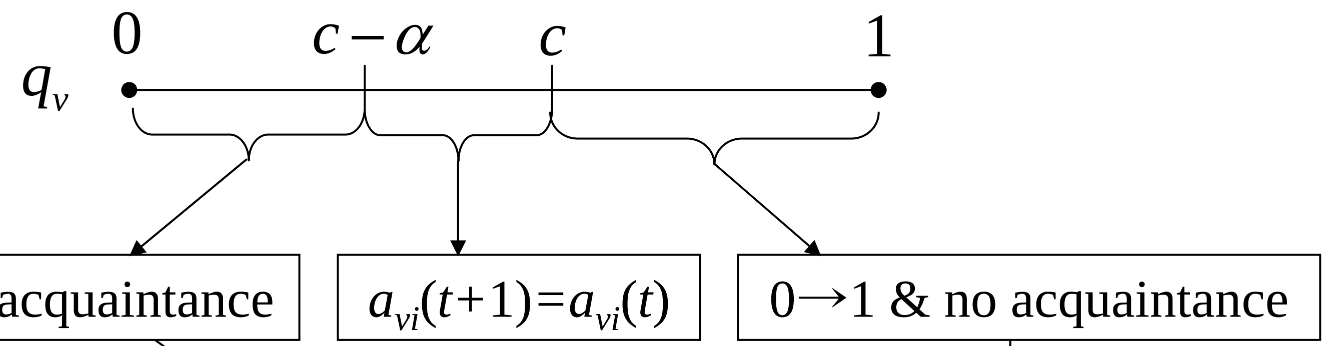
- Order parameter: helping rate, average linkage, social temperature

$$\langle a \rangle(t) = \frac{2}{N(N-1)} \sum_{i<j} a_{ij}(t) \qquad \langle a \rangle_k (t \to \infty) \equiv a_k$$

Case with α>0, β=0

- In case of $\beta = 0$, $a_{vi}(t+1) = \theta\left(q_v + \alpha a_{vi}(t) - c\right)$

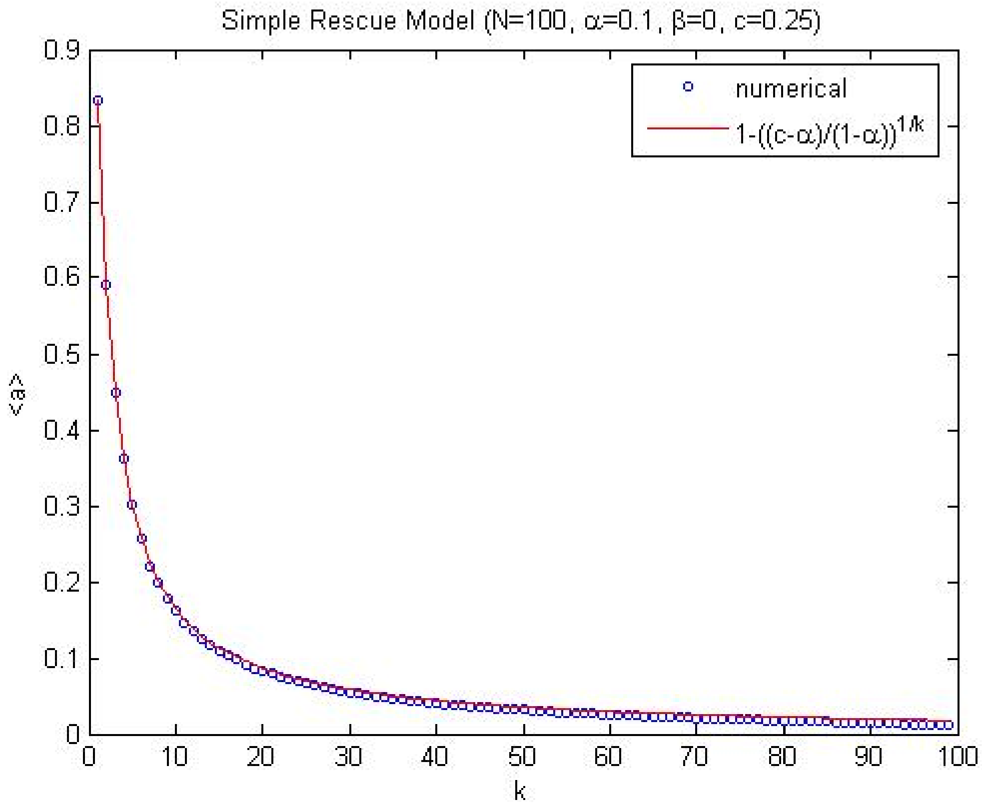




$$\frac{da_k(t)}{dt} = -W_{1\to 0} + W_{0\to 1} = -(c-\alpha)\left(1-(1-a_k)^k\right) + (1-c)(1-a_k)^k$$

- Stationary state (fixed k): $a_k = 1 - \left(\frac{c-\alpha}{1-\alpha}\right)^{1/k}$

Effect of Acquaintance (α>0)



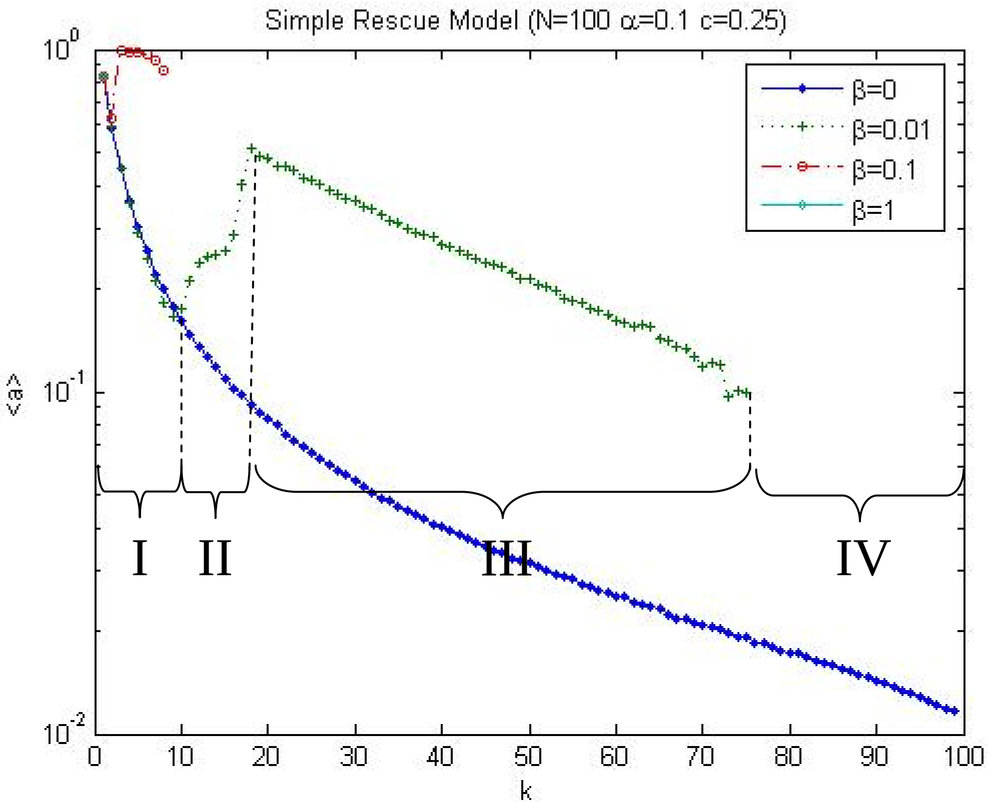
- The probability of acquaintance increases and that of failure too.

→ inevitable failure effect

- If $\alpha > c$, then a_k=1

- N=100, α=0.1, c_i=0.25 (homogenous non-adaptive agents)
- initial condition: no link

Effect of Coupling (β>0)



- I: just as for the case of β=0 → no coupling effect
- II: ? (bridge)
- III: similar to the case of β=0 but larger values
- IV: a_k=0 due to too much inhibiting bystanders

→ Coupling effect plays both positive and negative roles in emergencies.

Field Study: Urban vs. Rural

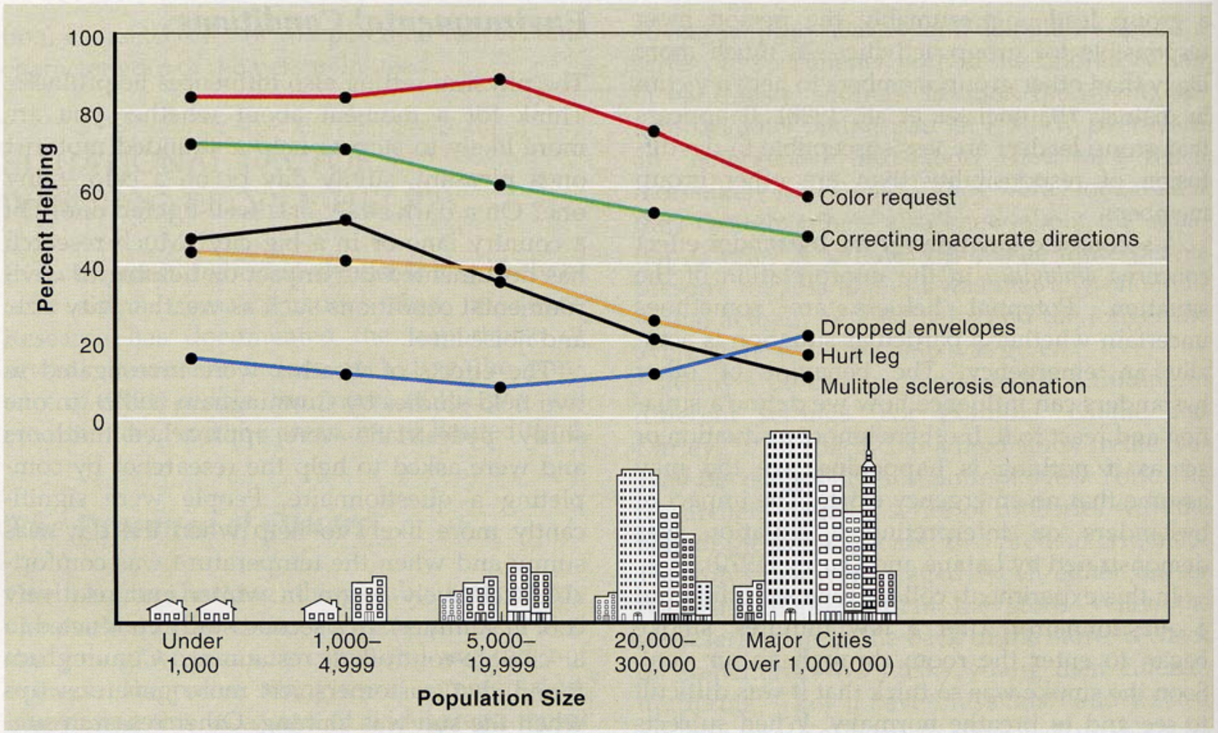
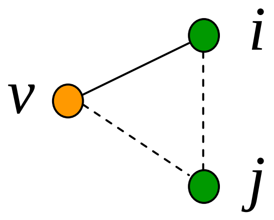


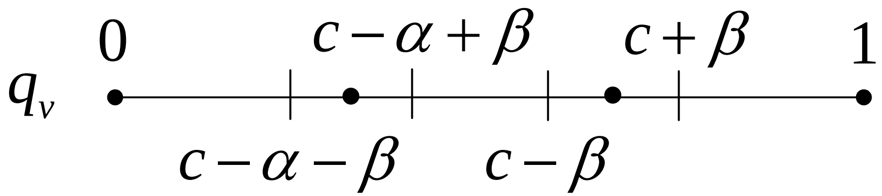
Figure 13-5 Research shows that strangers are more likely to receive help in small towns than in large cities. This figure shows the percentage of times that a stranger received five different kinds of help in cities of varying sizes. (*Source:* Adapted from Amato, 1983, p. 579.)

- Comparison of helping behavior in urban and rural environments: People who live in larger cities are less likely to help strangers.
- Amato (1983)

Case with β>0, k=2

- In case of $\beta > 0$, $a_{vi}(t+1) = \theta\left(q_v + \alpha \begin{pmatrix} 0 \\ 1 \end{pmatrix} + \boxed{\beta \begin{pmatrix} 1 \\ -1 \end{pmatrix}} - c \right)$





$$W_{0\to 1} = (1-c-\beta)(1-a_2)^3 + (1-c+\beta)a_2(1-a_2)^2$$

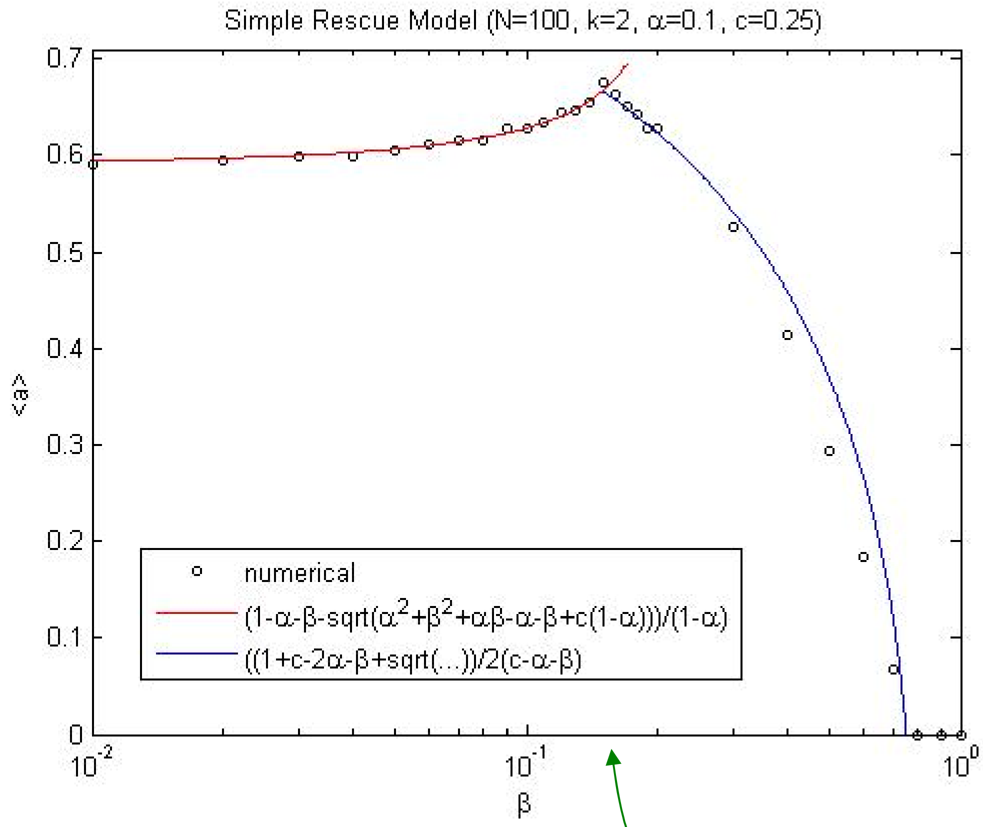
$$W_{1\to 0} = (c-\alpha+\beta)\left(2a_2(1-a_2)^2 + a_2^2(1-a_2)\right) + (c-\alpha-\beta)\left(2a_2^2(1-a_2) + a_2^3\right)$$

- Stationary state:

$$a_2 = \frac{1-\alpha-\beta-\sqrt{\alpha^2+\beta^2+\alpha\beta-\alpha-\beta+c(1-\alpha)}}{1-\alpha} \qquad c-\alpha-\beta \geq 0$$

$$a_2 = \frac{1+c-2\alpha-\beta-\sqrt{5c^2+4\alpha^2-3\beta^2-8\alpha c-2\beta c-2c+2\beta+1}}{2(c-\alpha-\beta)} \qquad c-\alpha-\beta < 0$$

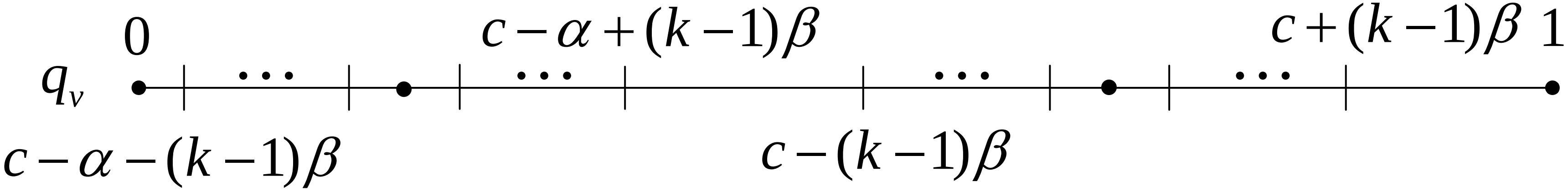
Optimal coupling strength



$$\beta_{opt} = c - \alpha$$

- There exists an optimal coupling strength to maximize the helping rate.

General Case with β>0



$$W_{0\to 1} = (1-a_k)^k (1-c+(k+1)\beta - 2\beta F(a_k,k))$$

$$W_{1\to 0} = (1-(1-a_k)^k)(c-\alpha-(k-1)\beta + 2\beta F(a_k,k))$$

$$F(a_k,k) = \sum_{n=0}^{k-2} (k-1-n) \binom{\frac{1}{2}k(k-1)}{n} a_k^n (1-a_k)^{\frac{1}{2}k(k-1)-n}$$

$$W_{0\to 1} = (1-c-(k-1)\beta)(1-a_k)^k$$

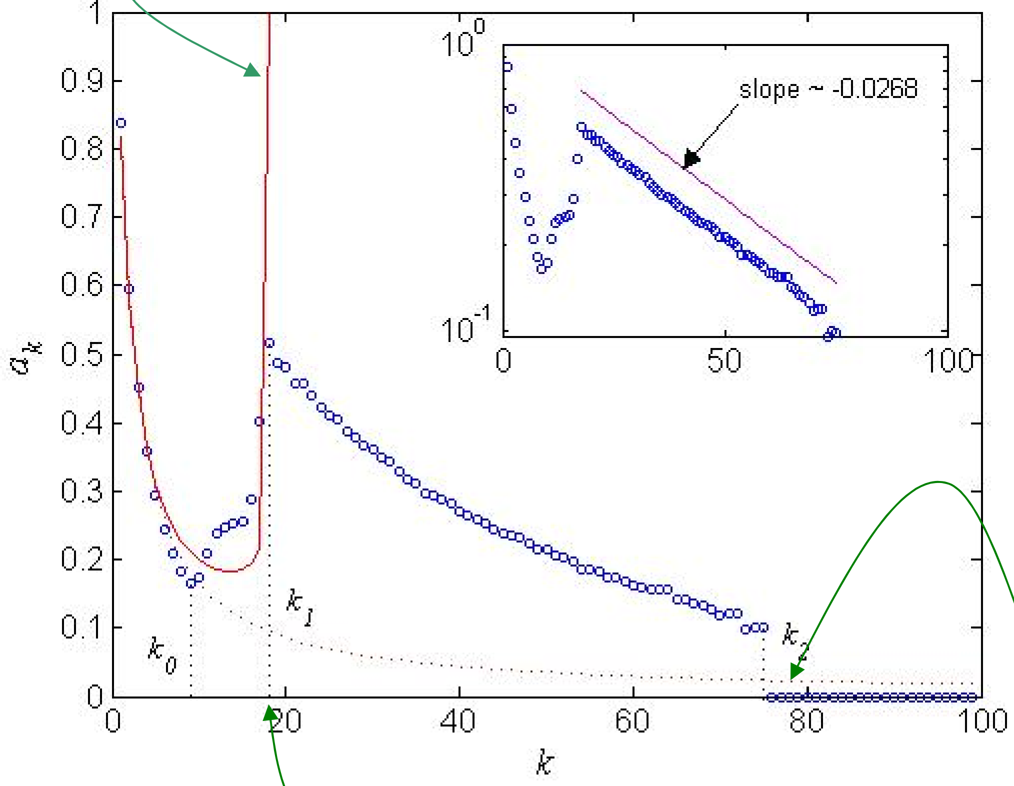
$$W_{1\to 0} = (c-\alpha-(k-3)\beta)\left(1-(1-a_k)^k\right)$$

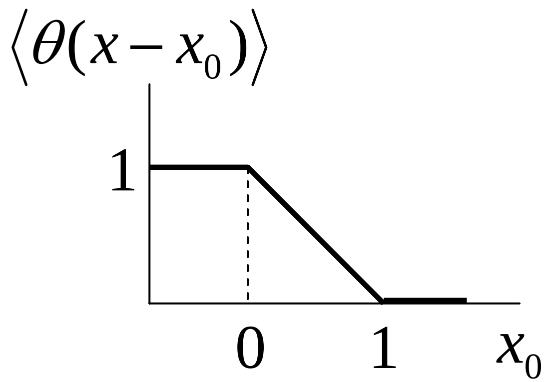
$\longleftarrow$ approximation

$$\therefore a_k = 1-\left(\frac{c-\alpha-(k-3)\beta}{1-\alpha-2(k-2)\beta}\right)^{1/k} \qquad k \le k_1 \equiv \frac{c-\alpha}{\beta}+3$$

Results

$$1-\left(\frac{c-\alpha-(k-3)\beta}{1-\alpha-2(k-2)\beta}\right)^{1/k}$$





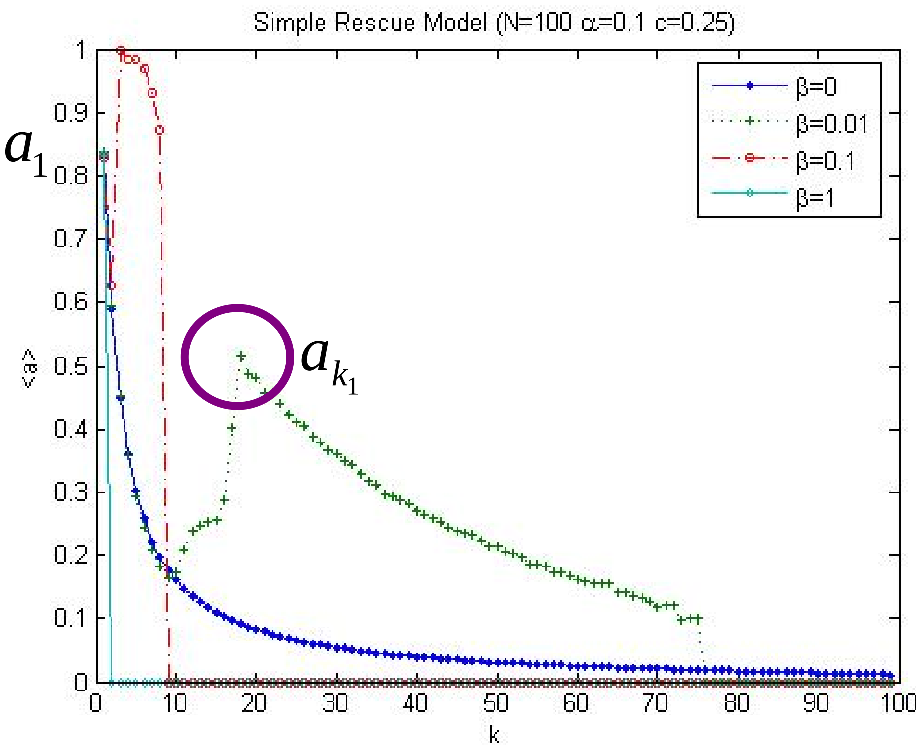
$$a_k = 0$$

$$c-\alpha a_k-\beta(k-1)(2a_k-1)=1$$

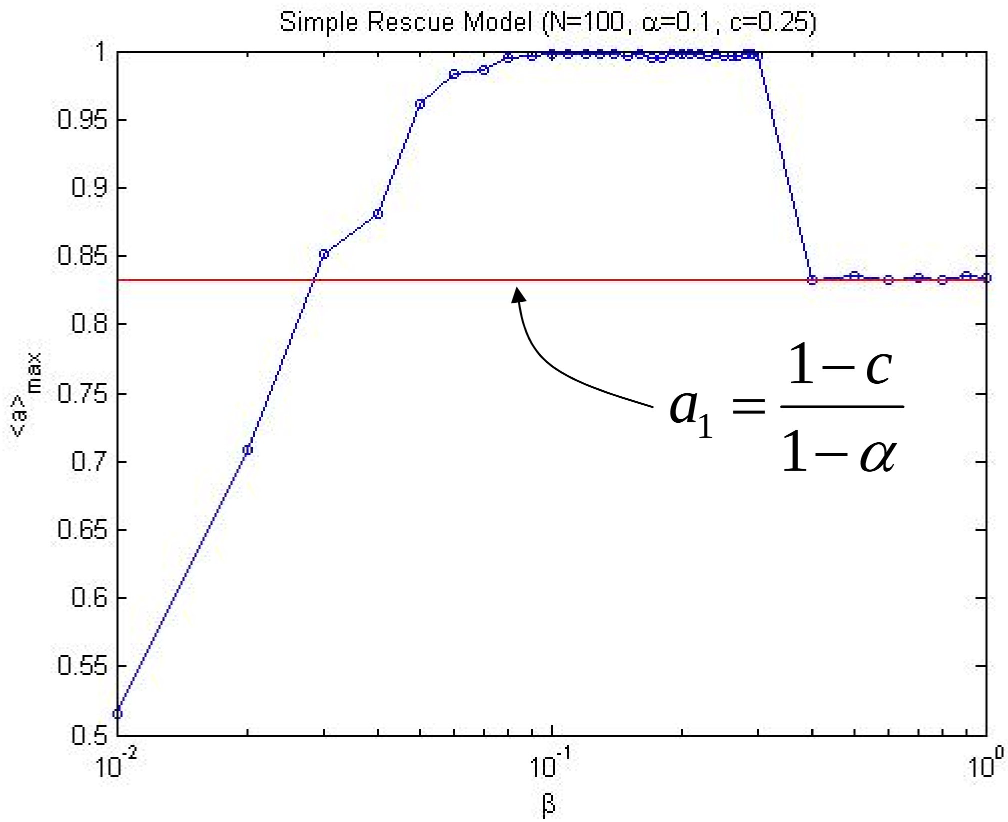
$$k_1=\frac{c-\alpha}{\beta}+3=18$$

$$k_2=\frac{1-c}{\beta}+1=76$$

Maximum helping rate?



$$0.08 < \beta < 0.35$$



Summary

- Rescue model reproduces the experimental result that the helping rates decrease as the number of bystanders increases.
- For some range of small k the helping rate increases according to k.
- In case of k=2, there exists an optimal coupling strength.
- Coupling effect plays both positive and negative roles.
- A broad range of coupling strength makes the helping rate maximized.

References

- http://en.wikipedia.org/wiki/Kitty_Genovese
- http://www.oldkewgardens.com/ss-nytimes-3.html
- B. Latane and J. M. Darley, American Scientist **57**, 244-268 (1969)
- B. Latane, American Psychology **36**, 343-356 (1981)
- P. R. Amato, Journal of Personality and Social Psychology **45**, 571-586 (1983)
- A. Nowak, J. Szamrej, and B. Latane, Psychological Review **97**, 362-376 (1990)
- M. Lewenstein, A. Nowak, and B. Latane, Physical Review A **45**, 763-776 (1992)
- J. A. Holyst, K. Kacperski, and F. Schweitzer, Physica A **285**, 199-210 (2000); Annual Reviews of Computational Physics **IX**, 253-273 (2001)
- J. Rasenberger, New York Times, February 8, 2004.
- S. Worchel, J. Cooper, and G. R. Goethals, Understanding Social Psychology 5th eds., Brooks/Cole Publishing Company (1991)
- S. H. Taylor, L. A. Peplau, and D. O. Sears, Social Psychology 8th eds., Prentice Hall (1994)