Social Network Analysis

Turning the Tide
Columbia University

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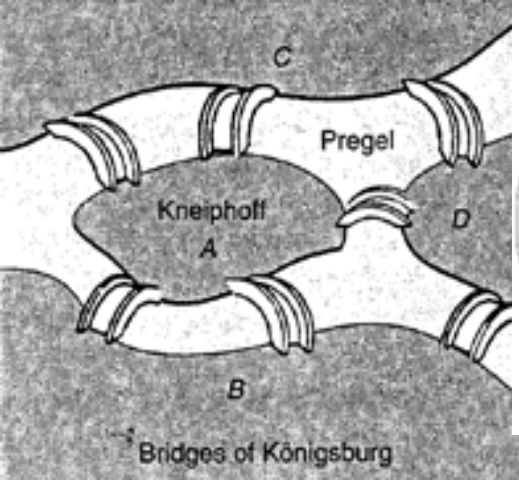
Keck Medicine of USC

Major Points

1) Social Network Theory & Analysis
2) Social Network Influences on Behavior (SNA **of** Behavior Change)
3) Social Network Analysis for Program Implementation (SNA **for** Behavior Change)
4) Network Interventions
5) Networks as Mediators and/or Moderators of Program Effectiveness

Social Networks are Ubiquitous & Varied

- Adolescent friendships
- Inter-organizational cooperation
- Email/phone communications
- Trading relations among nations
- Workplace advice-seeking
- Etc.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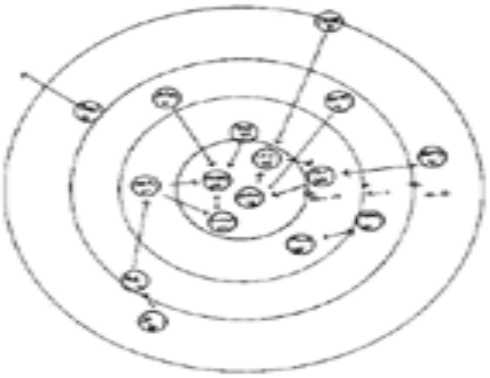
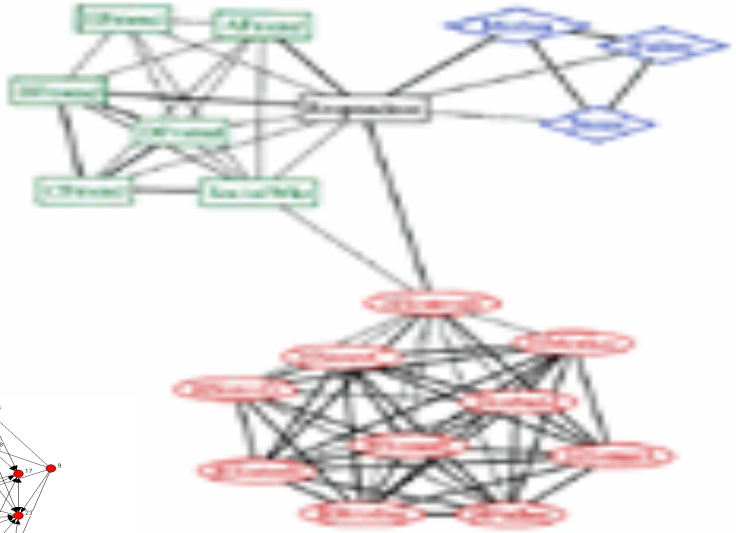
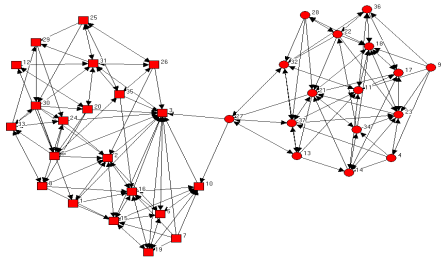
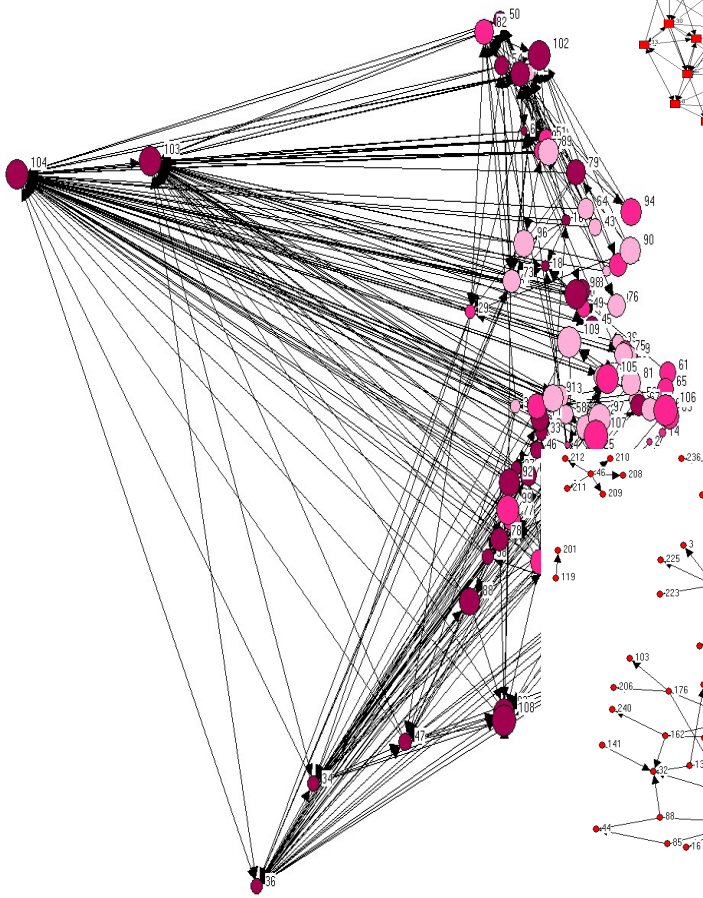
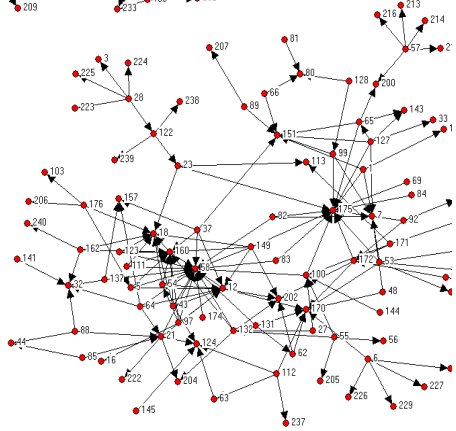
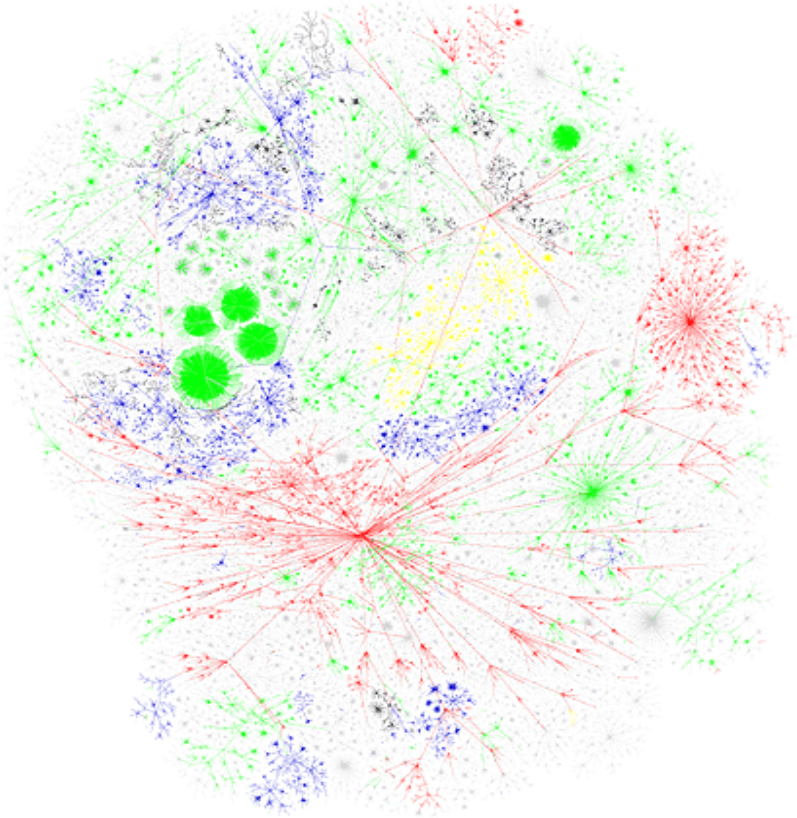




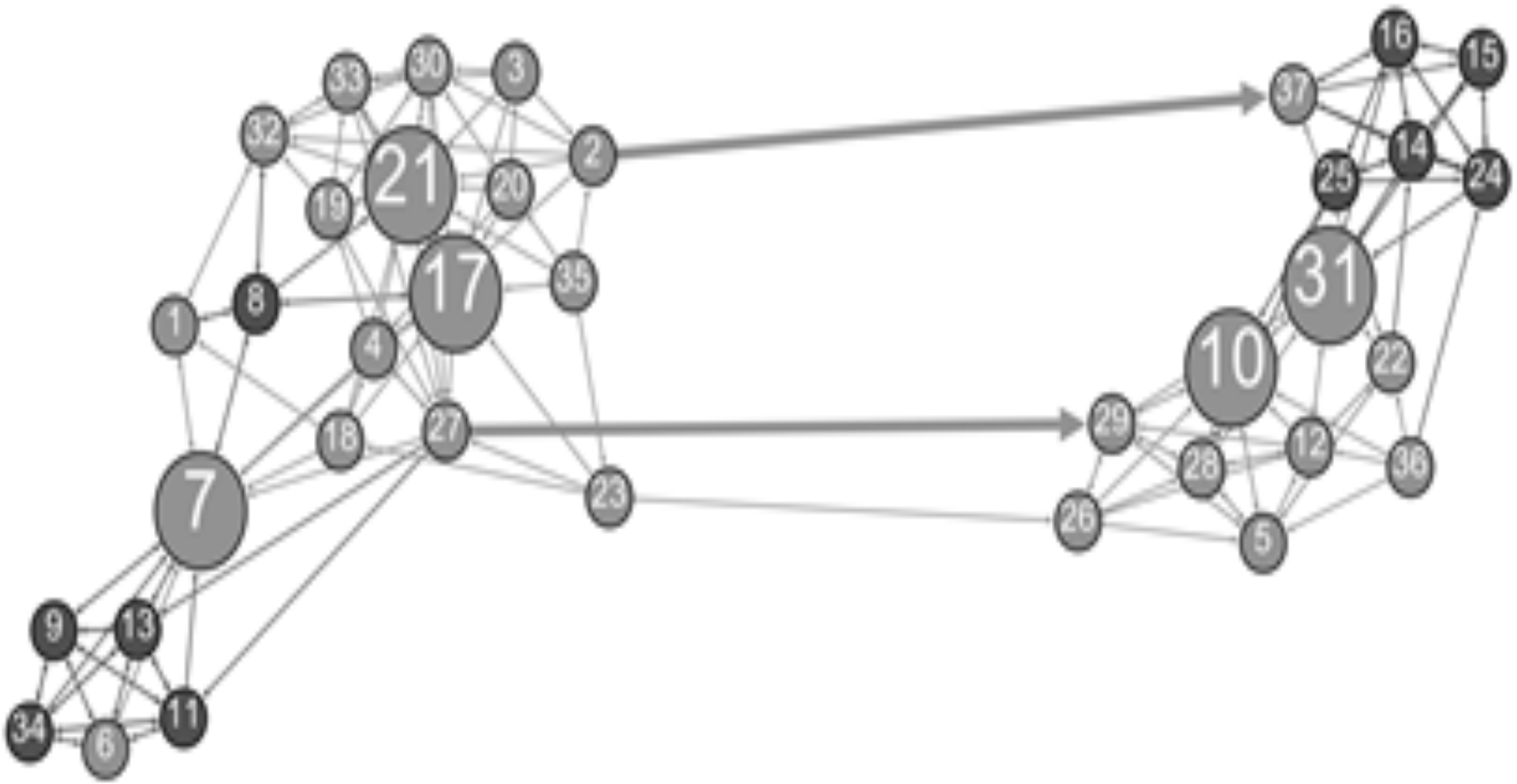




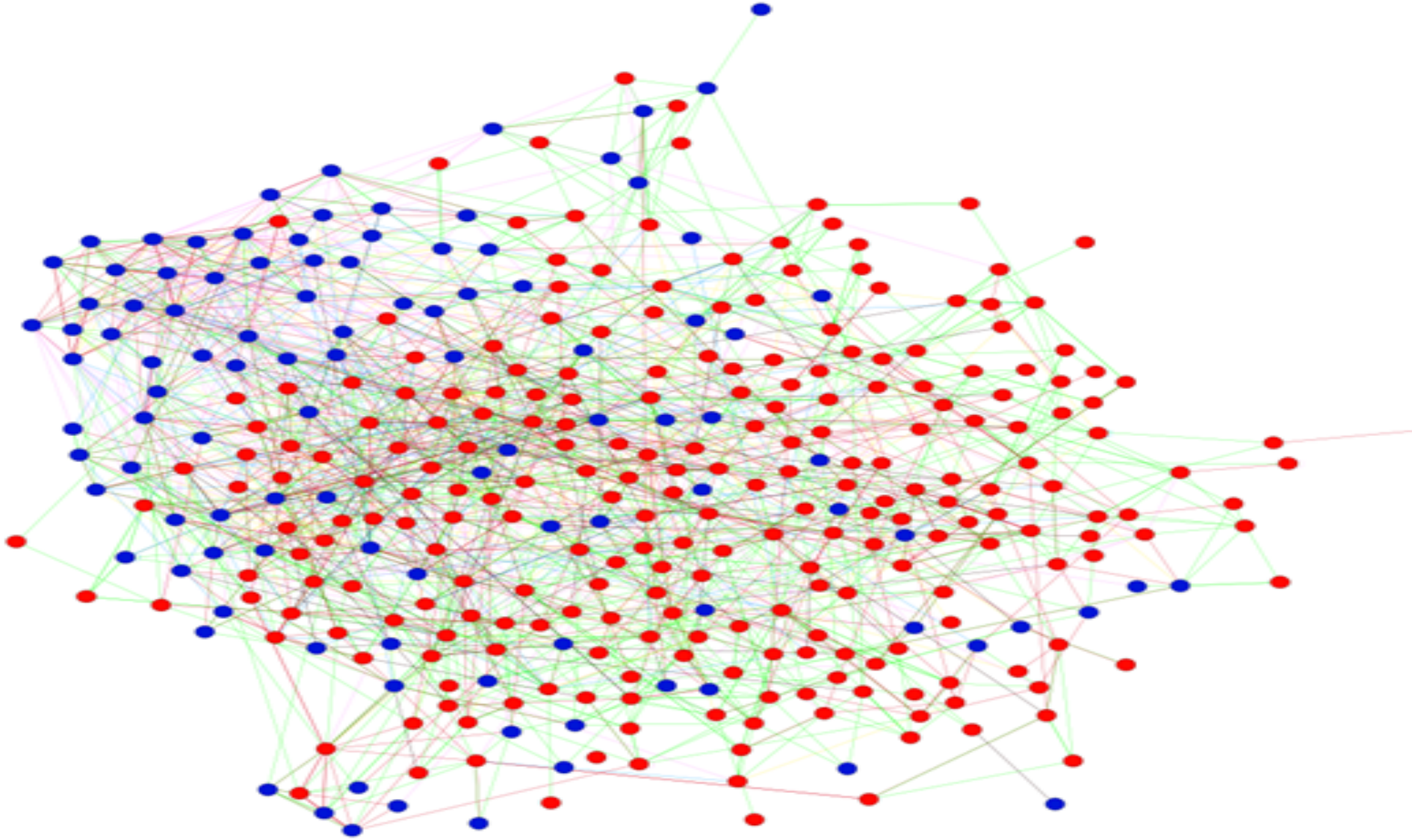


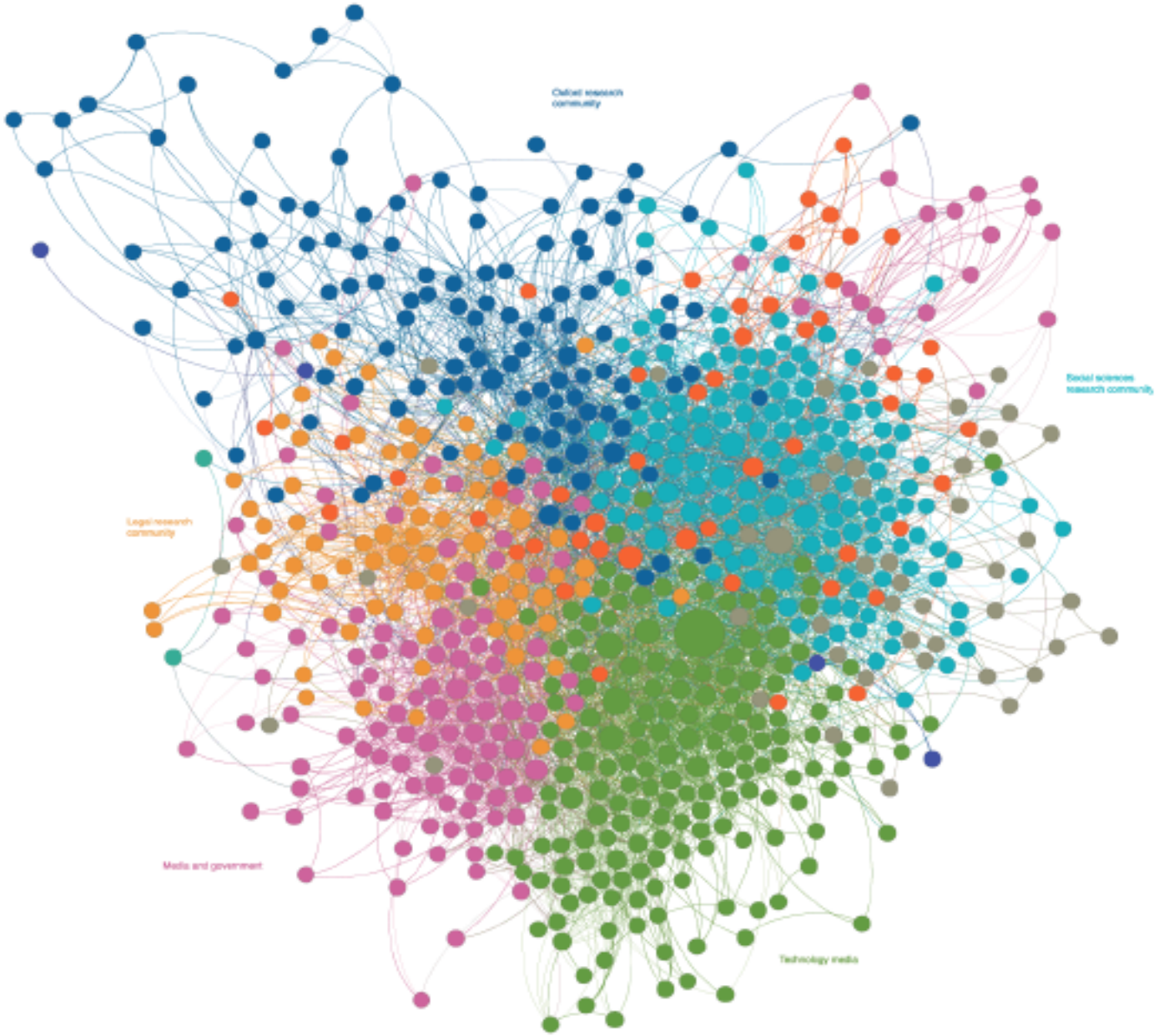


Classroom Friendships Among 12-year Olds



Relationships among10th graders





Twitter network, @OIIOxford. Source: Hogan, 2011

Influenza Pandemic, 1957

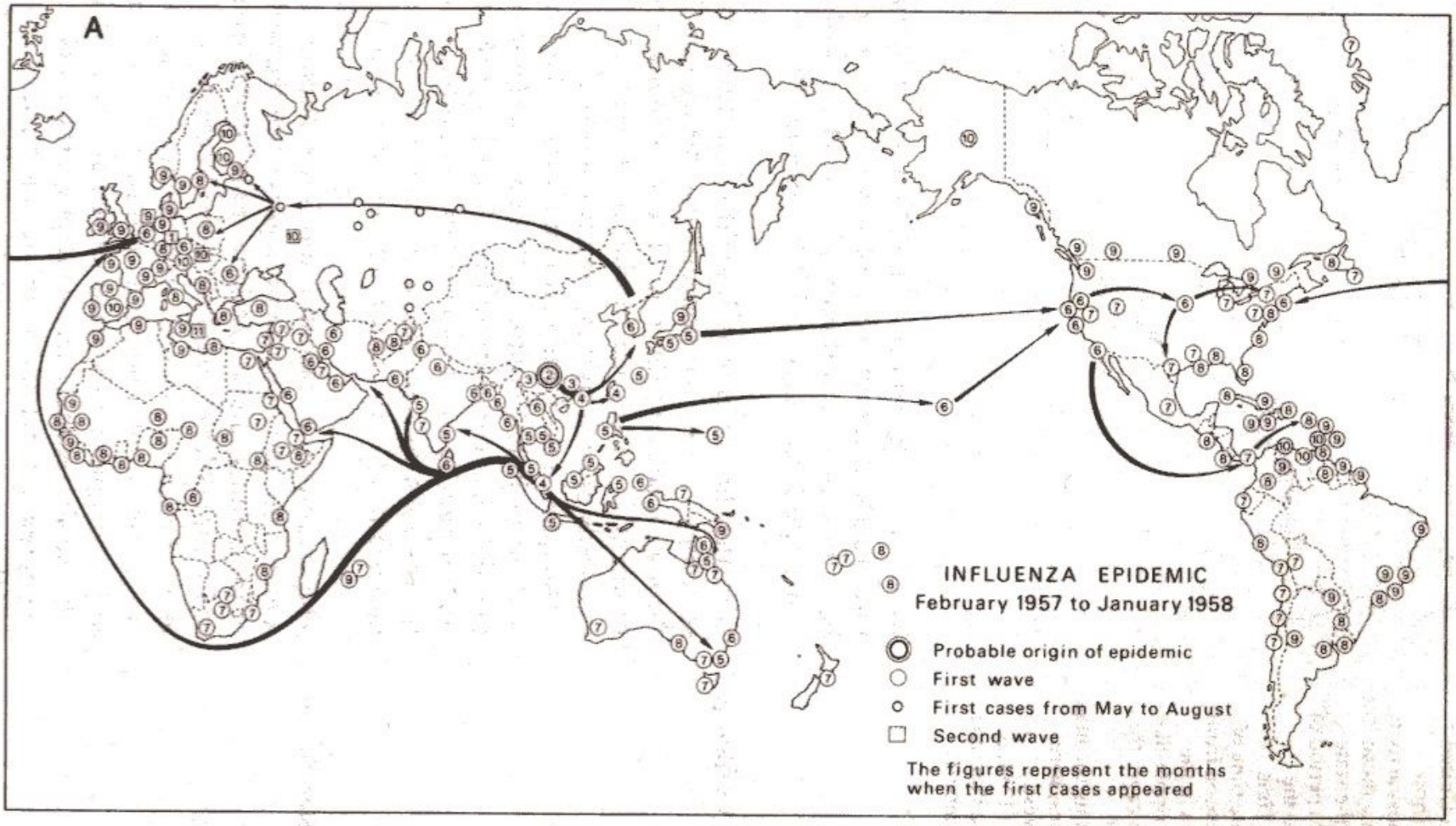
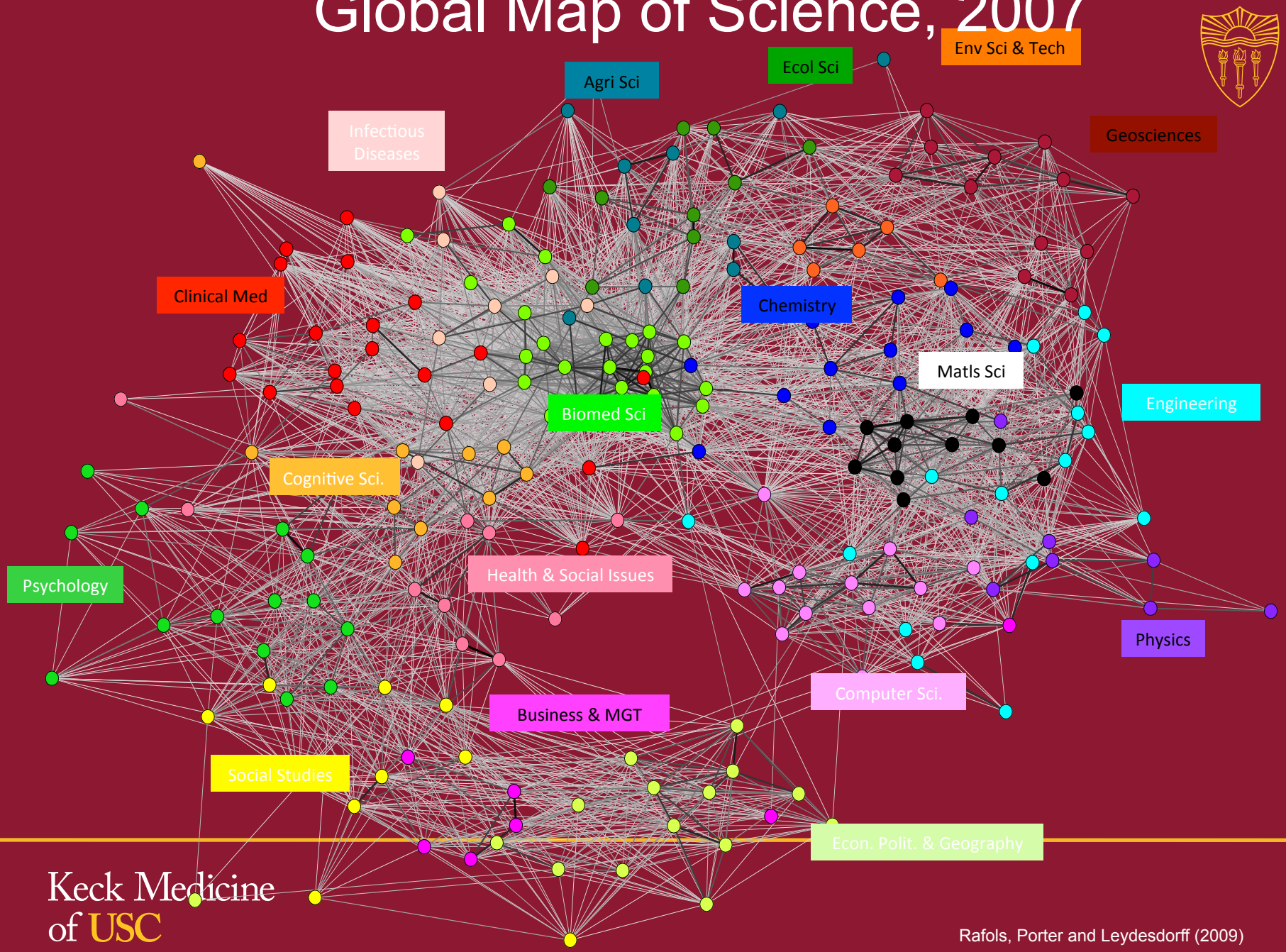


Fig. 2.7(A) Spread of the world influenza epidemic, 1957–8. *Source:* Stuart-Harris (1965, p. 103). (B) Diffusion of same epidemic on a local scale in northern England. *Source:* Hunter and Young (1971, p. 647).

Global Map of Science, 2007



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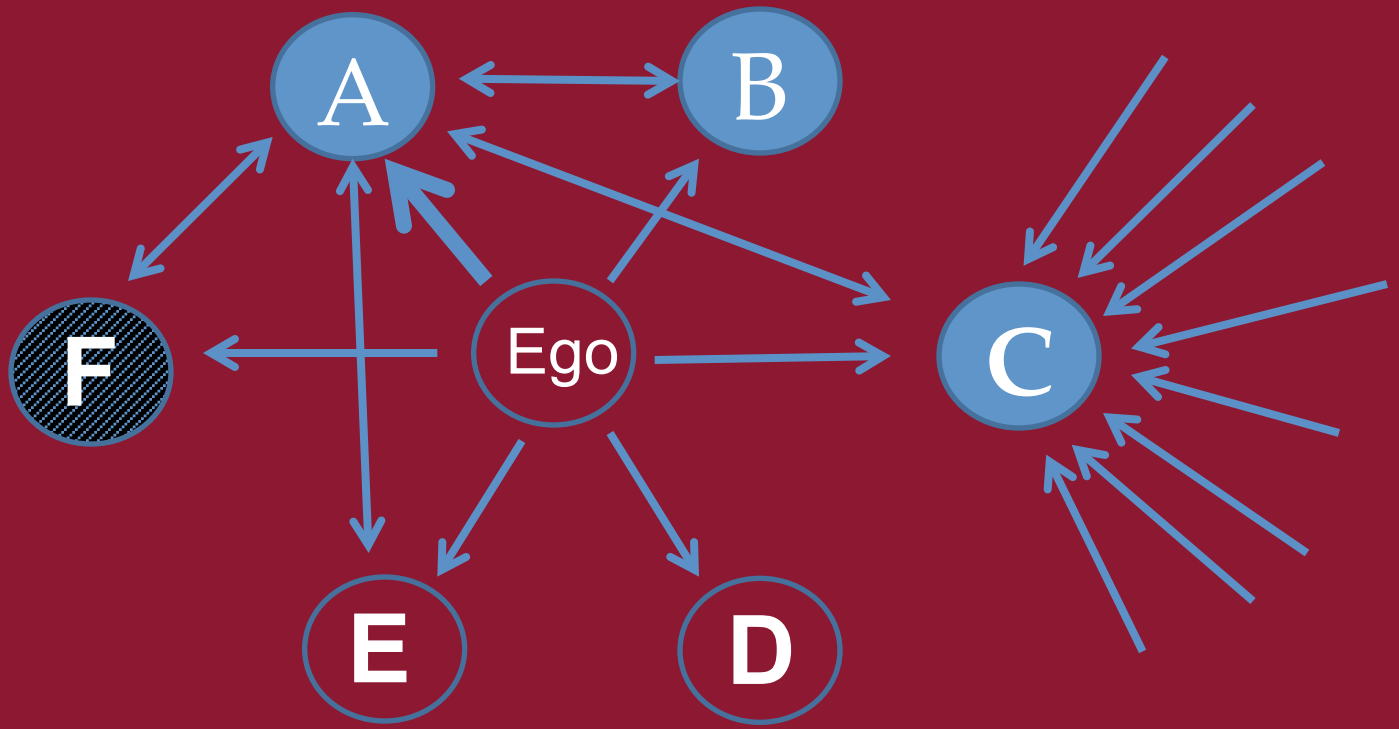
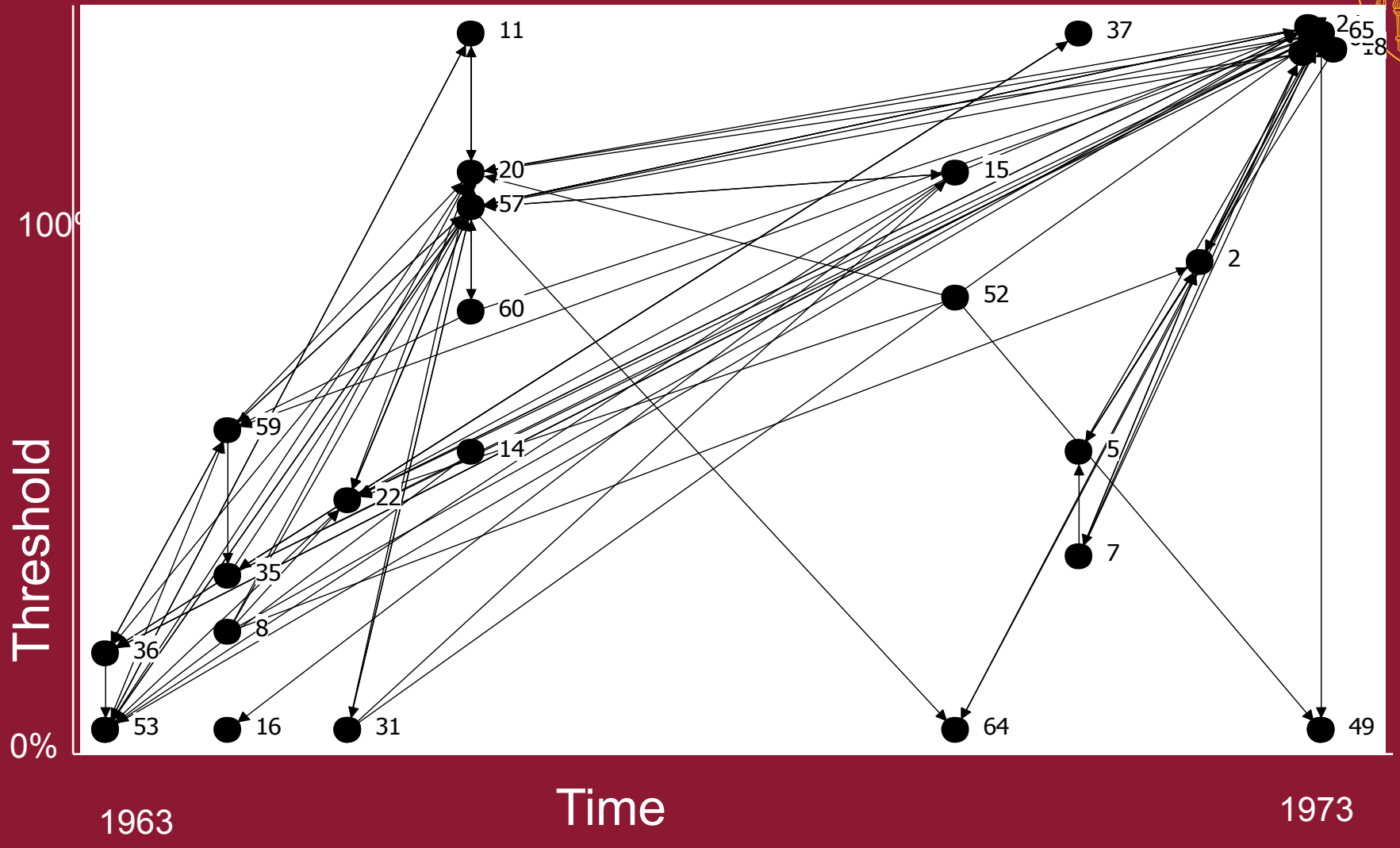
Rafols, Porter and Leydesdorff (2009)

Social Network Influences on Behavior (SNA of Behavior Change)

- Many models to explain how networks influence behavioral decisions/actions
- Network exposure model the most common.

Personal Network Environment Increases Influence

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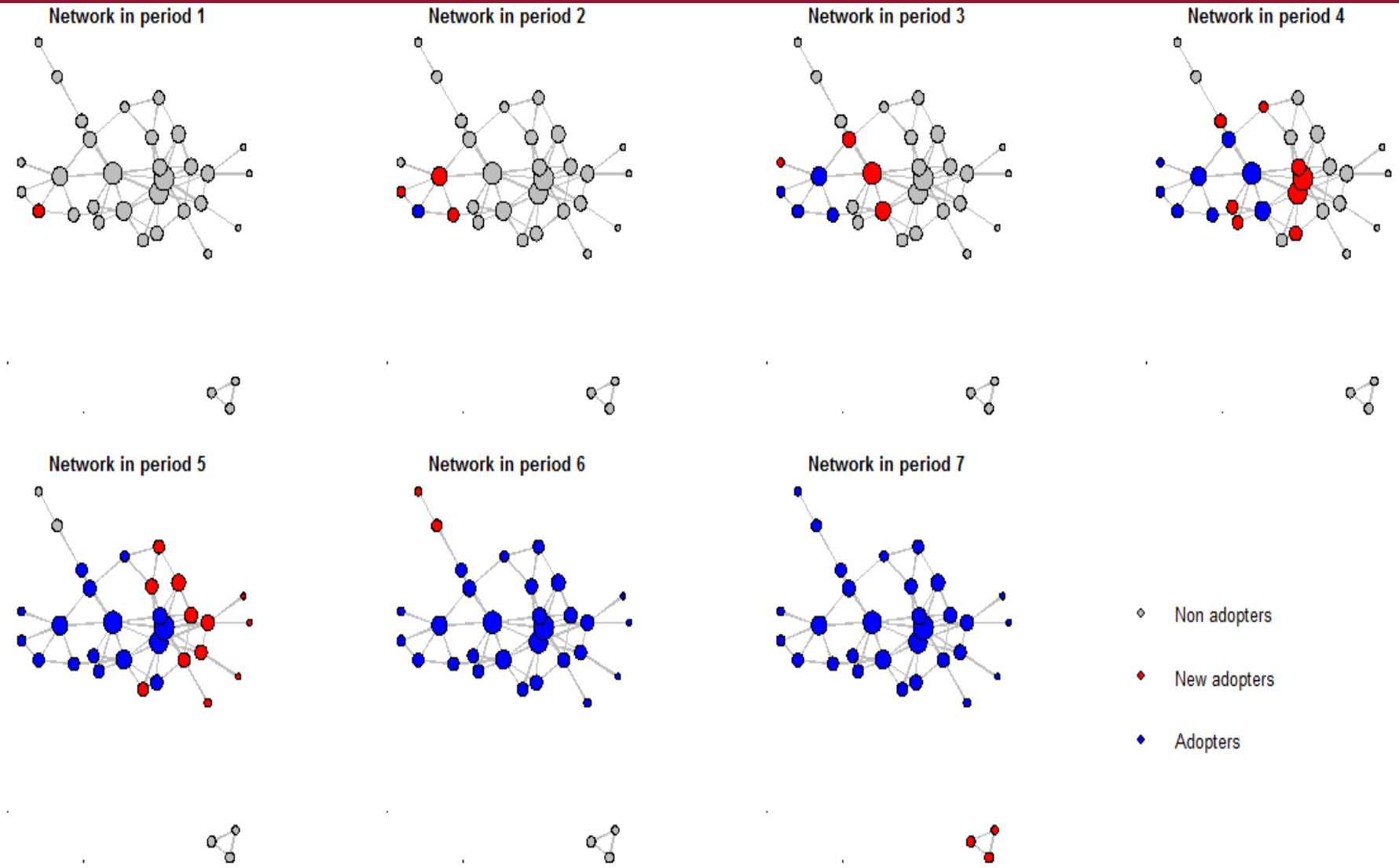
1973

Network Diffusion



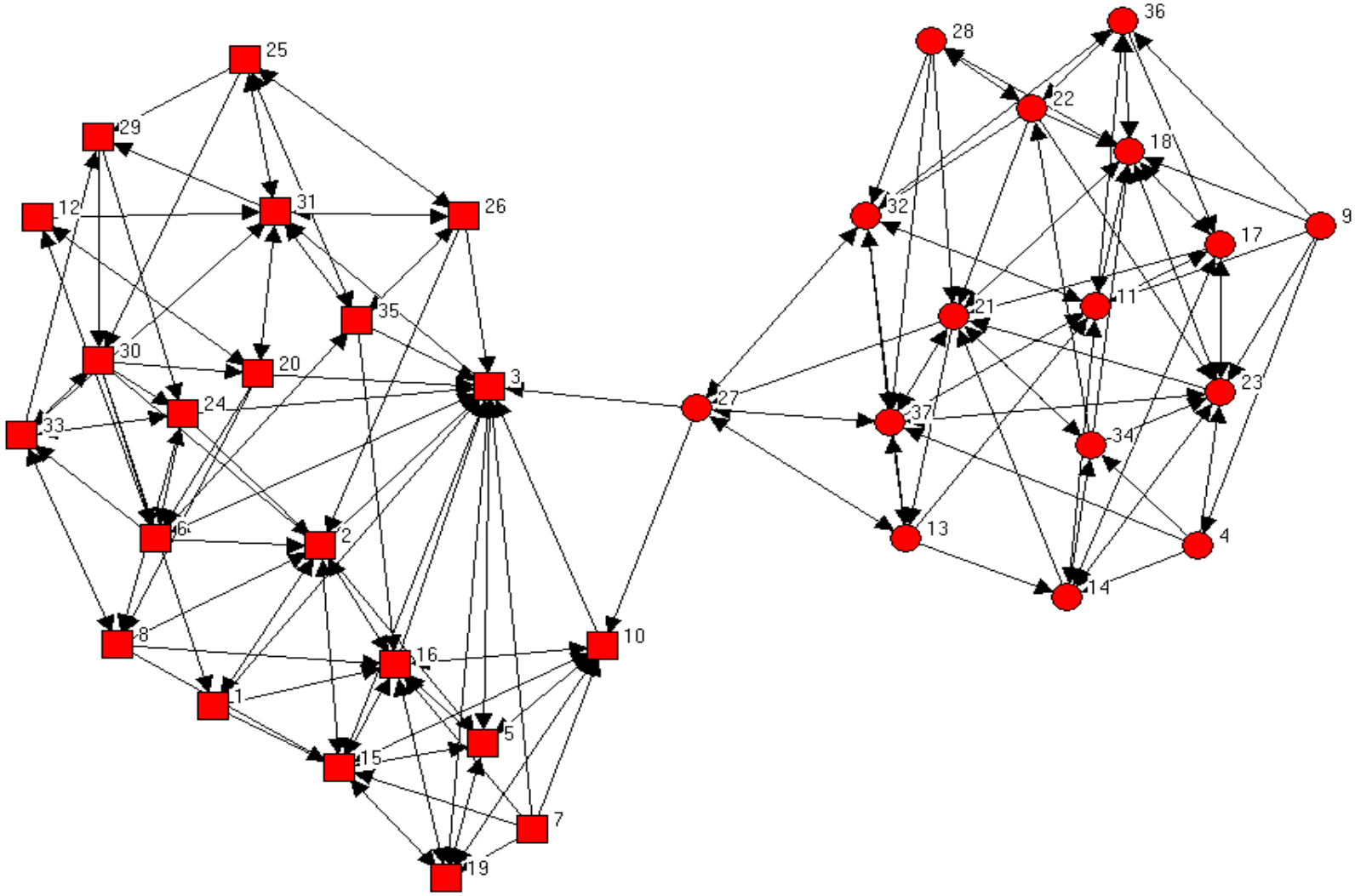
3) Networks Influences for Behavior Change

- If networks are so important, how can we use them to make things better?
- Can we use network data to design and implement better interventions?

Many Public Health Interventions Are Network Interventions

1. They promote seeking healthcare providers
2. They encourage people to talk about behaviors (e.g., couples who communicate about fertility preferences are more likely to use contraceptives)
3. They attempt to fragment transmission networks (e.g., clean syringes for IDUs)

Network Data Make the Process Explicit



PLOS ONE

RESEARCH ARTICLE

Social Network Analysis for Program Implementation

Thomas W. Valente[1]*, Lawrence A. Palinkas[2], Sara Czaja[3], Kar-Hai Chu[1], C. Hendricks Brown[4]

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Social Network Analysis for Program Implementation (SNAPI)

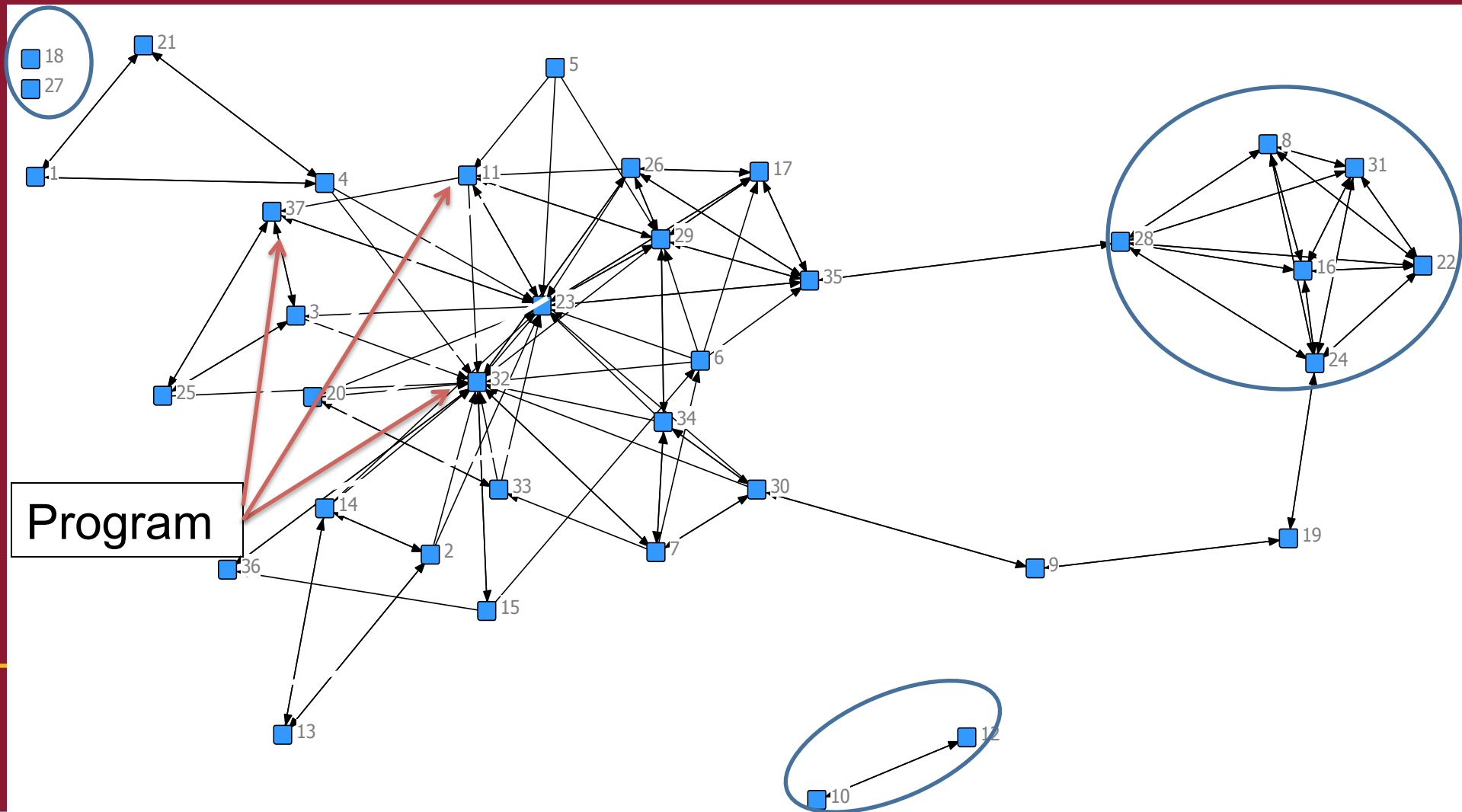
	Stage of Implementation			
	Exploration (Needs Assessment)	Adoption (Program Design)	Implementation	Sustainment & Monitoring
Concept	Network Ethnography	Network Interventions	Network Diagnostics	Network Surveillance
Outcomes	Document network position and structure of those providing input into problem definition.	Select network properties of intervention design.	Use network data to inform and modify intervention delivery.	Ensure continued program use by important network nodes.
Citation		Valente, 2012 [22]	Gesell et al., 2013 [70]	Iyengar et al., 2010 [75]

Exploration (Needs Assessment)

Network Ethnography

- Is there a network to work with?
- What is the network position of those defining the problem?
- Are there disconnected subgroups in the community?
- Are there isolates who need to be connected?

Who Provides Input for Problem Definition & Program Design?



Community as Network

- Makes explicit that problem definition and priority settings will vary depending on who provides input.
- Community based organizations are always confident they can hear the voice of the community, but we are all blind to the parts of the network we can't see.
- In this example, people somewhat central in the network are involved but still other segments are left out.

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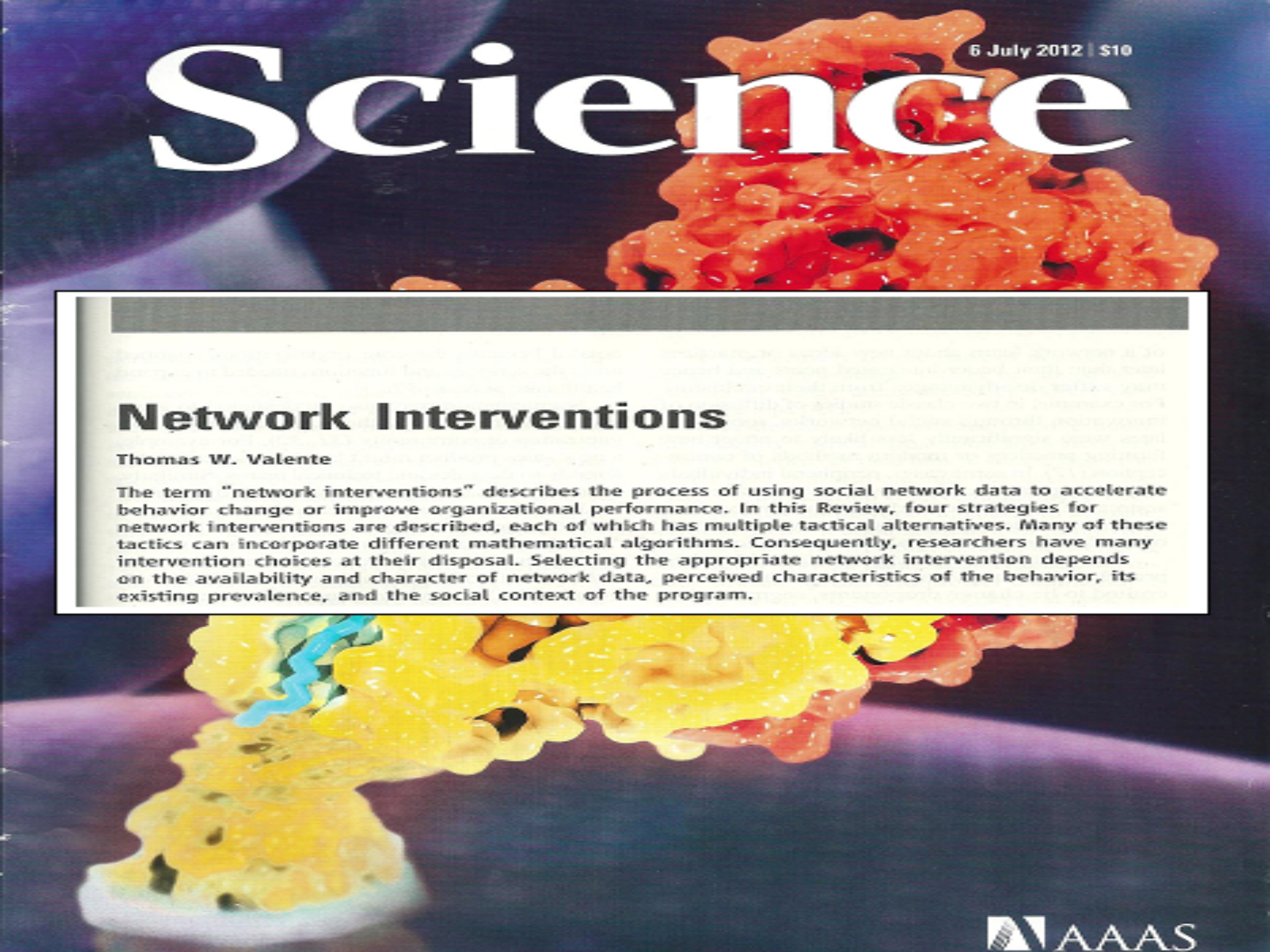
Science
6 July 2012 | $10

Network Interventions

Thomas W. Valente

The term "network interventions" describes the process of using social network data to accelerate behavior change or improve organizational performance. In this Review, four strategies for network interventions are described, each of which has multiple tactical alternatives. Many of these tactics can incorporate different mathematical algorithms. Consequently, researchers have many intervention choices at their disposal. Selecting the appropriate network intervention depends on the availability and character of network data, perceived characteristics of the behavior, its existing prevalence, and the social context of the program.



AAAS

Network Interventions

"Network interventions are purposeful efforts to use social networks or social network data to generate social influence, accelerate behavior change, improve performance, and/or achieve desirable outcomes among individuals, communities, organizations, or populations."

Principle 1: Program Goals Matter

- In some cases want to increase cohesion in others increase fragmentation
- Or increase/decrease centralization
- E.g., slowing spread of STDs may require fragmenting a sexual contact network or accelerating adoption condoms.
- Network Interventions Are not Agnostic to Content.

Principle 2: Behavioral Theory

- The type of change desired will be guided by theory
- Understanding motivations for and barriers against behavior change is critical.
- A well-articulated theory of the behavior is often critical for successful interventions.

Principle 3: Learn As Well As Induce

- The interventionist should use network methodology to learn from the community as much as try to influence it.
- Programs which meet the needs of their audiences are better received than those designed asymmetrically.

A Taxonomy of Network Interventions

Strategy	Tactic	Operationalization
Identification	Leaders Bridges Key Players Peripherals Low Thresholds	Degree, Closeness, etc. Mediators, Bridges Positive, Negative Proportions, Counts
Segmentation	Groups Positions	Components, Cliques Structural Equivalence, Hierarchies
Induction	WOM Snowball Matching	Random Excitation RDS, Outreach Leaders 1st, Groups 1st
Alteration (Manipulation)	Deleting/Adding Nodes Deleting/Adding Links Rewiring	Vitality On Cohesion, Others On Network, On Behavior

Operational-ization

Operational-ization

Operational-ization

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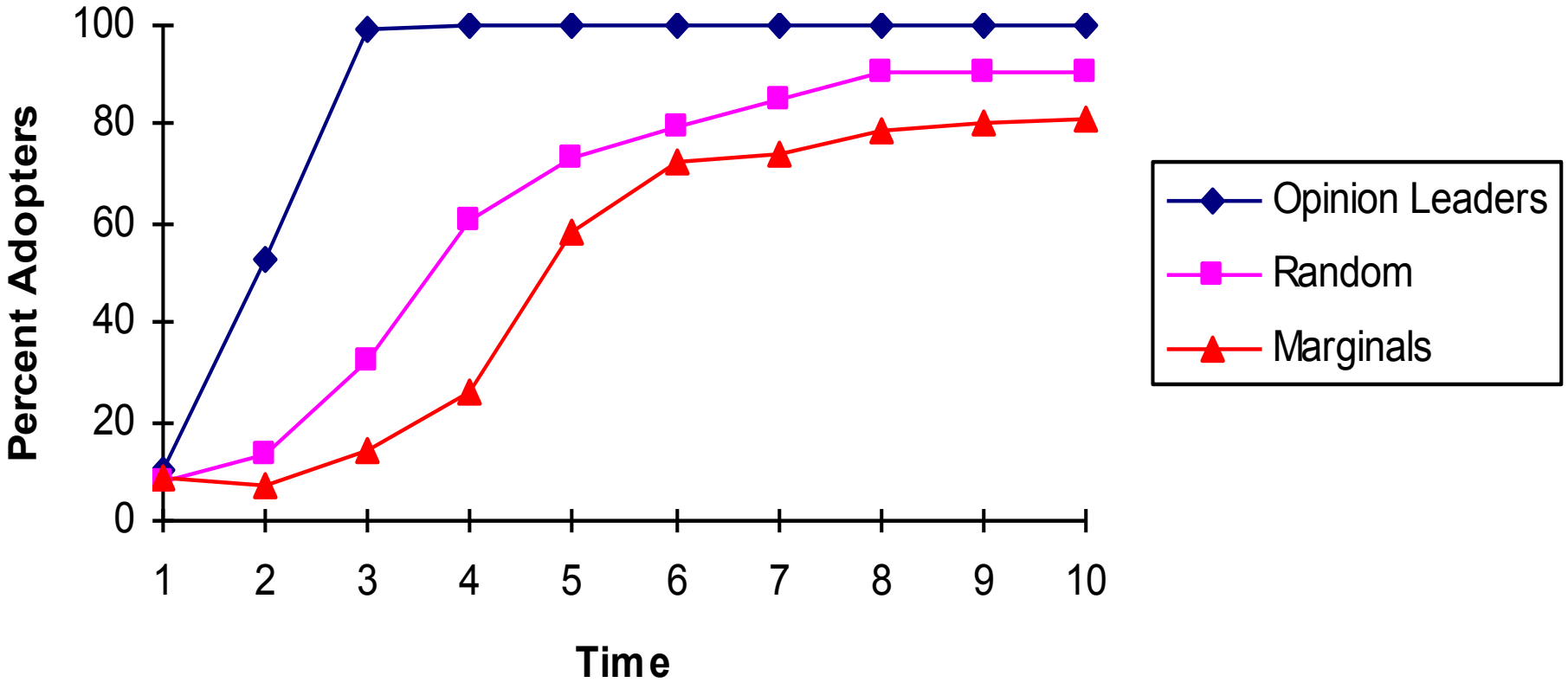
Opinion Leaders

- The most typical network intervention
- Easy to measure
- Intuitively appealing
- Proven effectiveness
- Over 20 studies using network data to identify OLs and hundreds of others using other OL identification techniques

Diffusion Network Simulation w/ 3 Initial Adopter Conditions



Cochrane Review of OL Studies (Flodgren, et al., 2011)

- 18 trials
  - 5 trials OL vs. No Intervention, +0.09;
  - 2 trials OL vs. 1 Interventions, +0.14;
  - 4 trials OL vs. 2+ Interventions, +0.10; and
  - 10 trials OL+ vs. + Interventions, +0.10.
- Overall, the median adjusted RD was +0.12 representing 12% absolute increase in compliance.

10 Methods Used to Identify Peer Opinion Leaders

Method	Technique
1. Celebrities	Program recruits well-known people to promote behavior.
2. Self-selection	Staff requests volunteers in-person or via mass media and those who volunteer are selected.
3. Self-identification	Surveys are administered to the sample, and questions measuring leadership are included. Those scoring highest on leadership scales are selected.
4. Staff selected	Program implementers select leaders from those whom they know.
5. Positional Approach	Persons who occupy leadership positions such as clergy, elected officials, media and business elites, and so on are selected.
6. Judge's Ratings	Persons who are knowledgeable identify leaders to be selected.
7. Expert Identification	Trained ethnographers study communities to select leaders.
8. Snowball method	Index cases provide nominations of leaders or are in turn interviewed until no new leaders are identified.
9. Sample Sociometric	Randomly selected respondents nominate leaders and those receiving frequent nominations are selected.
10. Sociometric	All (or most) respondents are interviewed and those receiving frequent nominations are selected.

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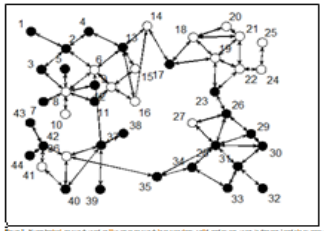
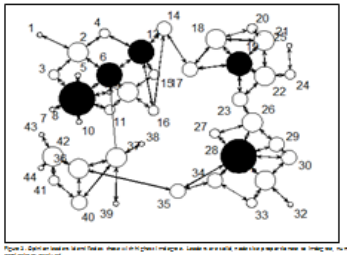
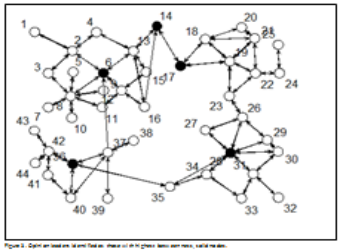
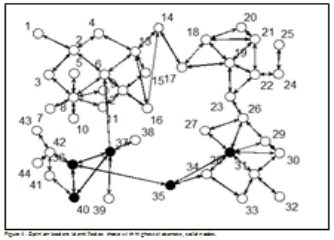
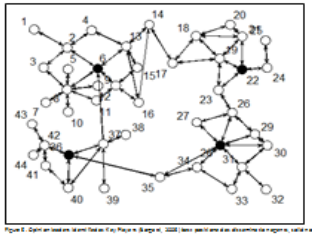
Graphical Displays of Intervention Choices

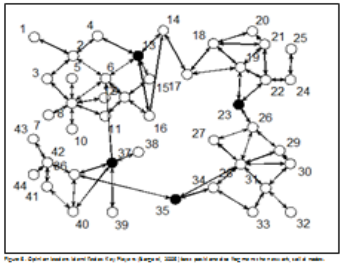


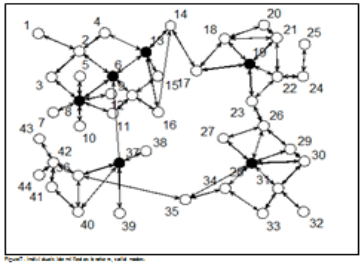


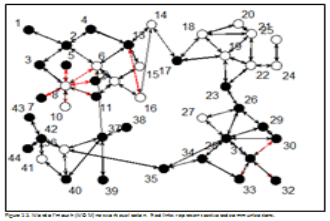


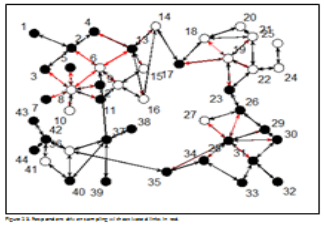


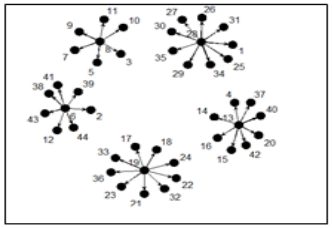


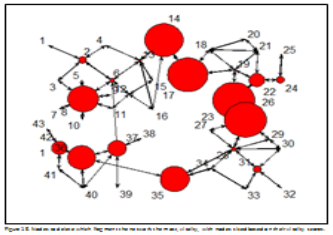


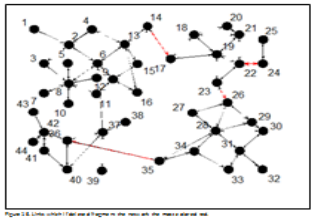


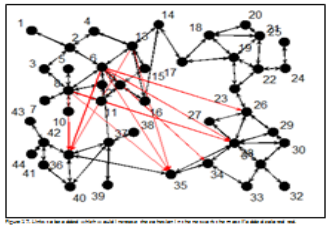


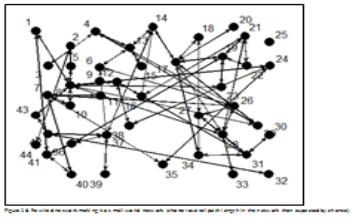












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Selecting a Network Intervention

- Availability and type of data
  - Types of networks
  - Existing network structure
- Behavioral characteristics
  - Existing prevalence
  - Perceived characteristics such as cultural compatibility; cost; trialability; etc.

Linking Theory to Intervention Strategy

- There are several theoretical mechanisms that drive contagion and/or behavior change.
- Evidence for a particular mechanism suggests choice of intervention strategy or tactic.

Influence Mechanisms Aligned with Interv. Choices

Mechanism	Tactic
Power Conflict Cohesion Isolation Thresholds	Leaders Bridges Key Players Peripherals Low Thresholds
Group Identification Structural Equivalence	Groups Positions
Information diffusion Hard to reach populations Closure Homophily	WOM Snowball Outreach Matching
Attributes Structure Structure!!	Deleting/Adding Nodes Deleting/Adding Links Rewiring

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Network Diagnostics

Gesell *et al. Implementation Science* 2013, **8**:116
http://www.implementationscience.com/content/8/1/116

IMPLEMENTATION SCIENCE

METHODOLOGY **Open Access**

Social network diagnostics: a tool for monitoring group interventions

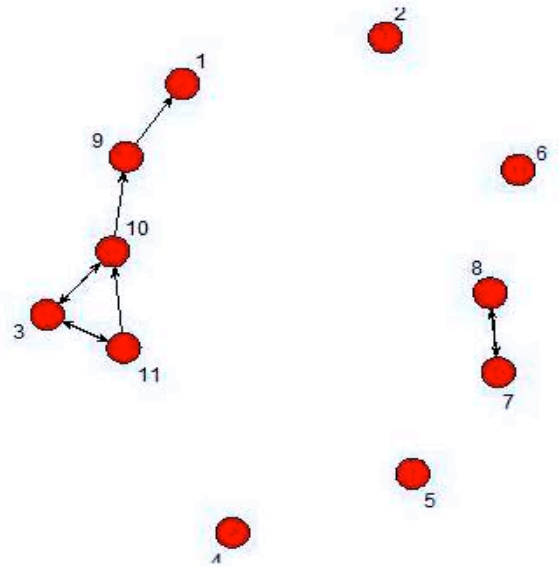
Sabina B Gesell[1,2*], Shari L Barkin[3] and Thomas W Valente[4]

Network Diagnostics Tool

Metric	Threshold	Examples of teaching methods thought to improve network structure
Isolates	Value should be equal to 0	Give each participant the opportunity to be part of the conversation.
Degree	Value should be greater than 1	Pair highly connected group members with others in small group activities in session.
Reciprocity	Values should be >0.50	Interventionist to pair non-reciprocated links: If A sends a tie to B, but B does not send a tie to A, then Interventionist will pair A and B in small group activities in session.
Components	Value should be equal to 0	Create bridges: Pair members from different subgroups in small group activities in session.
Density	Value should be >0.15 but <0.50	Begin each session with an interactive, personalized, community-building ice breaker.
Centralization	Values should be <0.25	Avoid pairing central nodes with isolates.
Transitivity	Values should be >0.3	Bring triads together for activities. If A is friends with B and C, connect B and C.
Cohesion	Values should be <0.50 (±.25)	Challenges group to make and meet a shared common goal (e.g., weekly wellness challenge: 15 minutes of walking per day).

Action Report for Group Leader

Map of Advice Network at Session 4:



Menu of Action Steps for Sessions 7-12:
(Please use at least 2 in the next session)

1. These group members are not connected to anyone in their group:
   Tammy
   Denise
   Cara
   Lisa
   Please make sure they do not feel excluded. If it is possible to catch them alone, please check in with them to let them know we care and ask how GROW is going for them. Please do not put any of them on the spot publically.

2. Please call on these group members to answer questions in session with the goal of not letting them fade into the background.
   Tammy
   Denise
   Cara
   Lisa
   Later in the session, refer back to what they say to show their input is valued.

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Networks as Mediators and/or Moderators

- Initial evidence suggests that program effectiveness depends on individual- and network-level characteristics.
- Moderators: Program works for people without users in the network (low threshold adopters for example)
- Mediators: Program designed to increase social support seeking.

Conclusions

- Social network theory and analysis has been around for decades
- The field is expanding rapidly today due to the many applications in all areas of science
- It's almost as if we went from 2 dimensions to 3