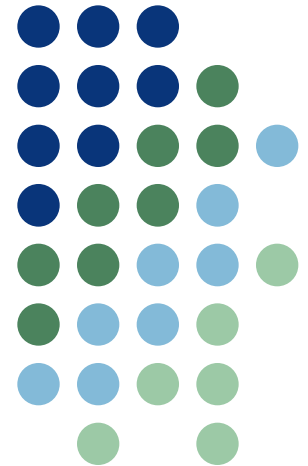


The application of social network analysis to health behavior interventions

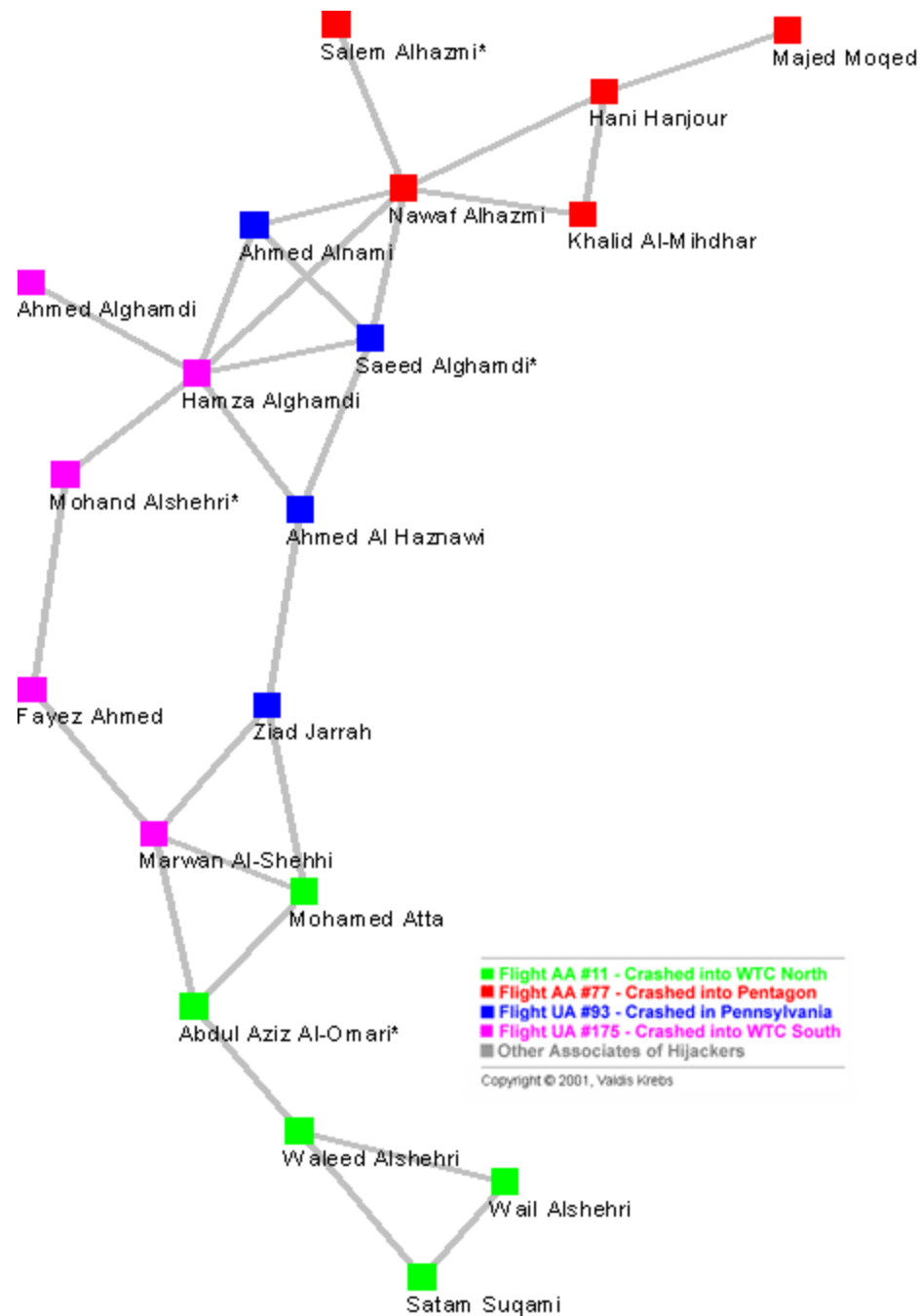
Douglas Luke
Washington University in St. Louis

National Institutes of Health
April 3, 2014



Goals

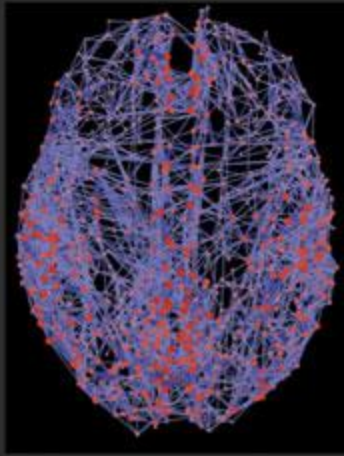
- What are social networks? Conceptual model and examples
- Social networks, chronic diseases, and health behavior
- Using social networks in behavioral interventions



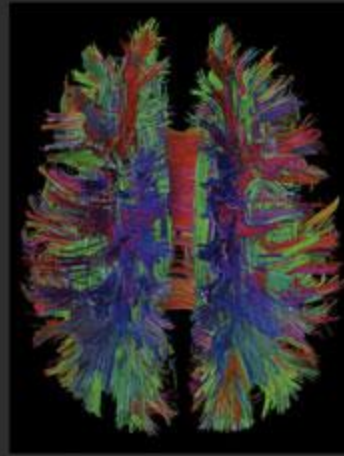
The Human Connectome



Anatomy
Klingler's method for fiber tract dissection uses freezing of brain matter to spread nerve fibers apart. Afterwards, tissue is carefully scratched away to reveal a relief-like surface in which the desired nerve tracts are naturally surrounded by their anatomical brain areas.



Connectome
Shown are the connections of brain regions together with "hubs" that connect signals among different brain areas and a central "core" or backbone of connections, which relays commands for our thoughts and behaviors.

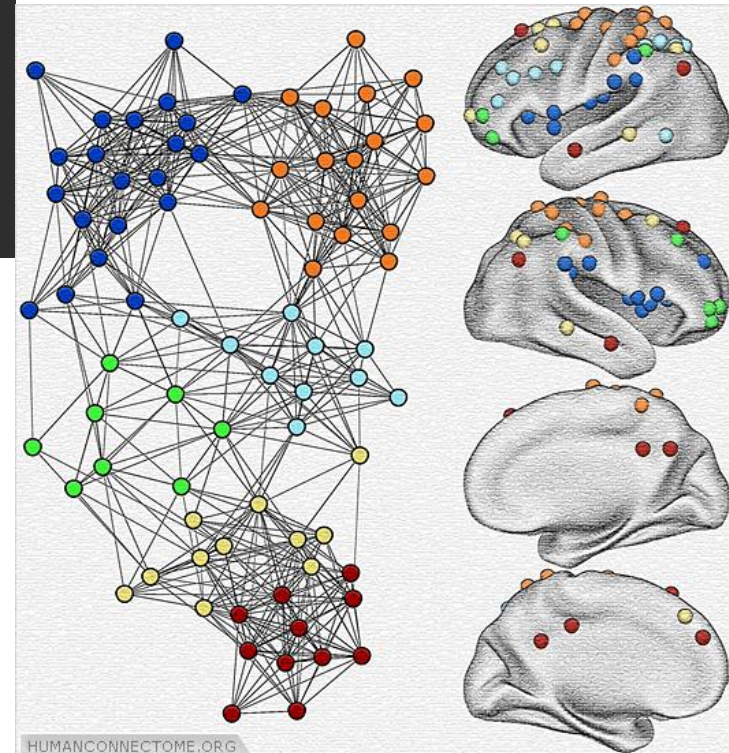


Neuronal Pathways
A new MRI technique called diffusion spectrum imaging (DSI) analyzes how water molecules move along nerve fibers. DSI can show a brain's major neuron pathways and will help neurologists relate structure to function.

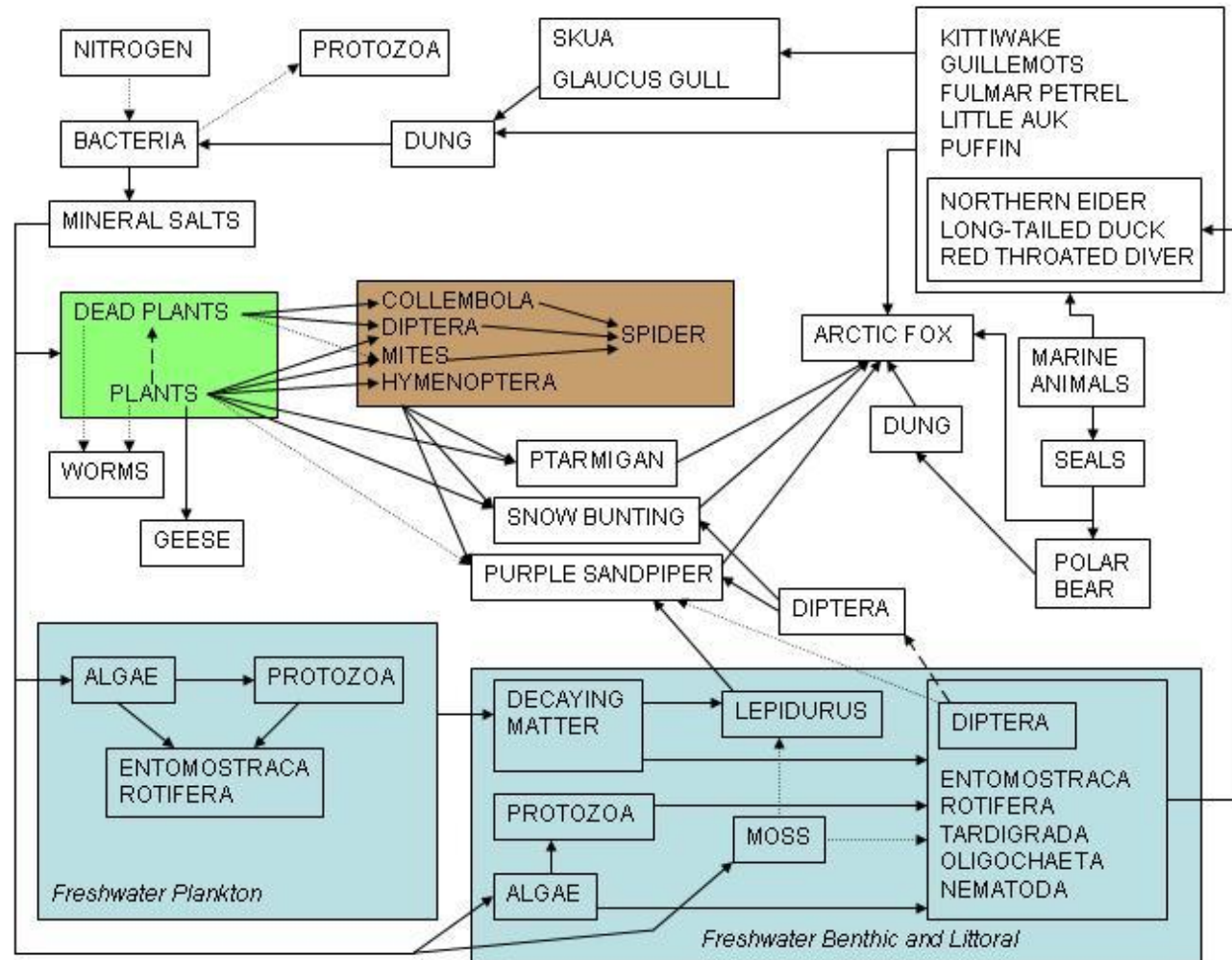
The brain as a large network:

- 10^{11} neurons
- 10^{15} synaptic connections

- <http://humanconnectome.org/>
- <http://13pt.com/projects/nyt110621/>



Biological networks: Food webs

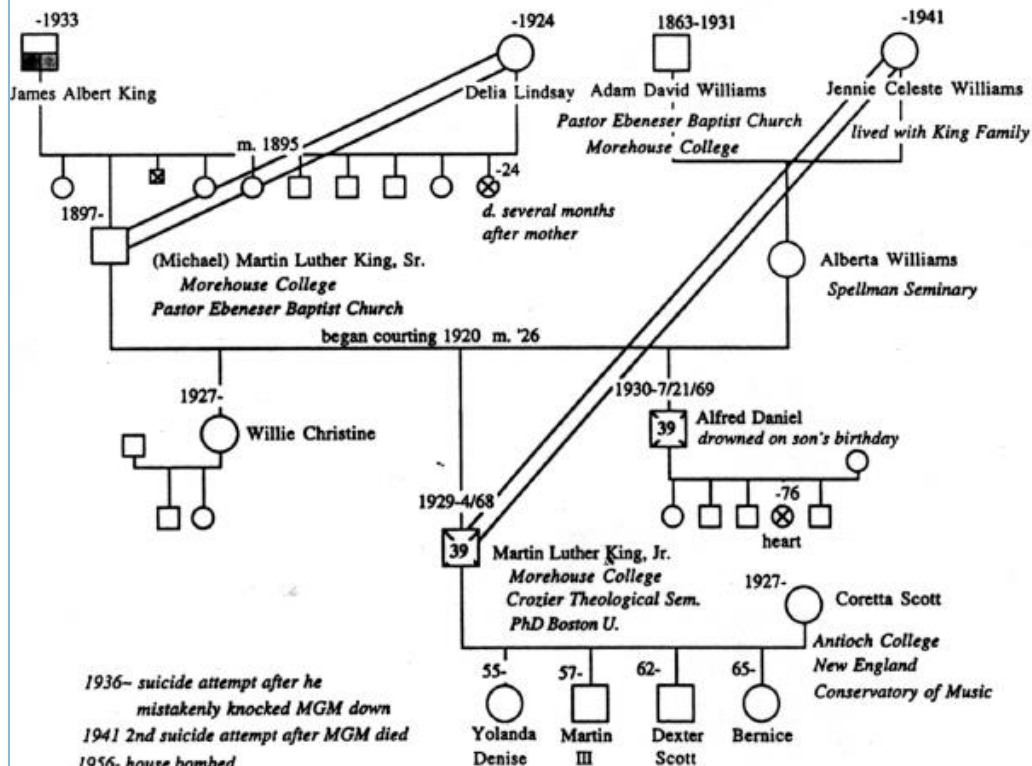


(Wikipedia:
Summerhayes &
Elton's 1923 food
web of Bear Island)

Social networks

MLK Genogram

Genogram 4.16 Martin Luther King family

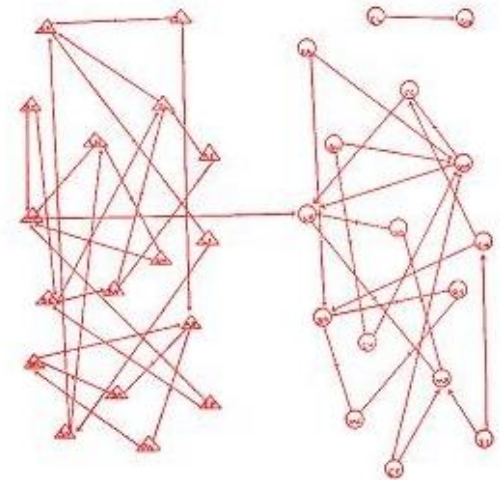


EMOTIONS MAPPED BY NEW GEOGRAPHY

Charts Seek to Portray the
Psychological Currents of
Human Relationships.

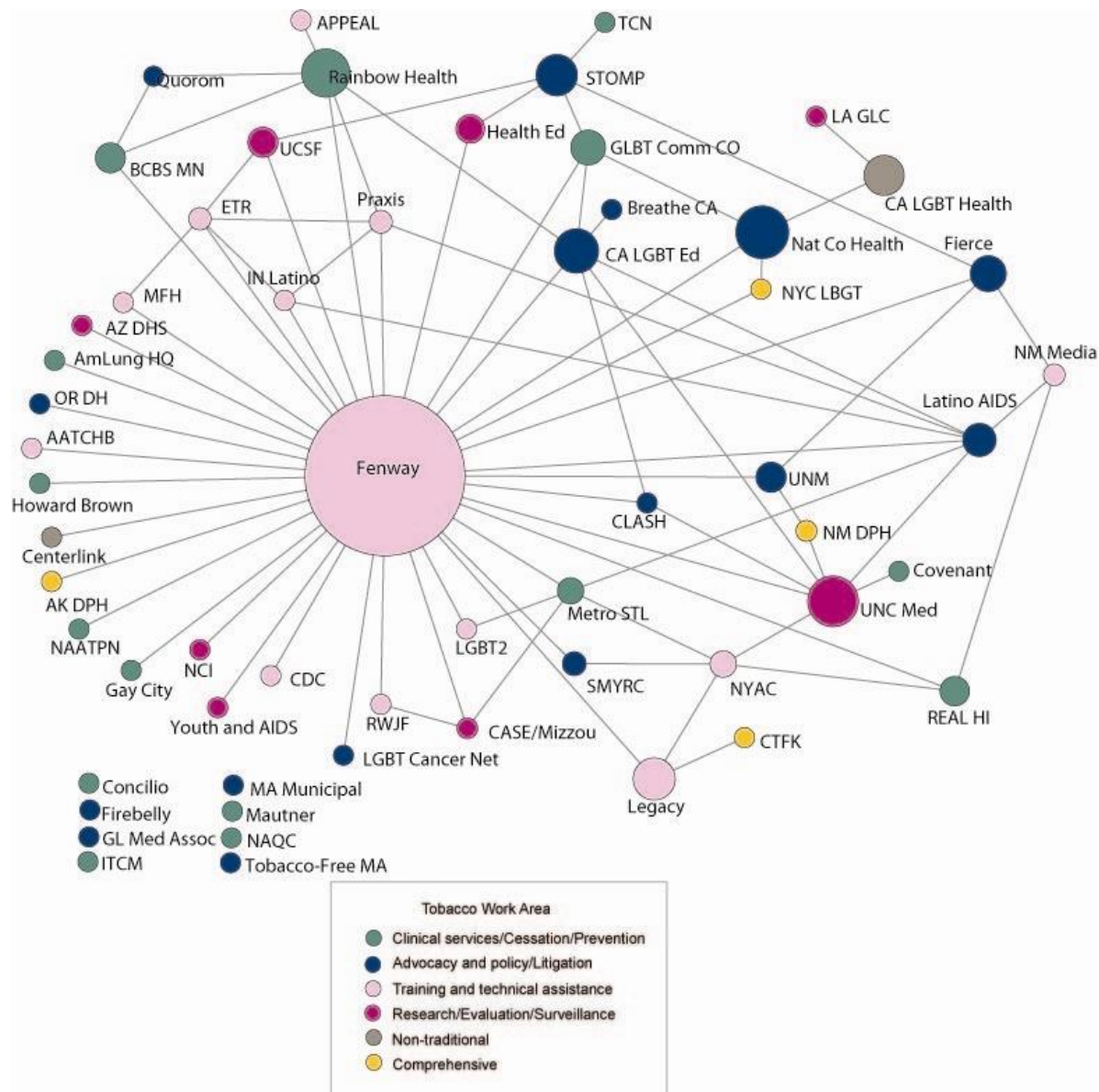
New York Times

April 3, 1933



Moreno Sociogram

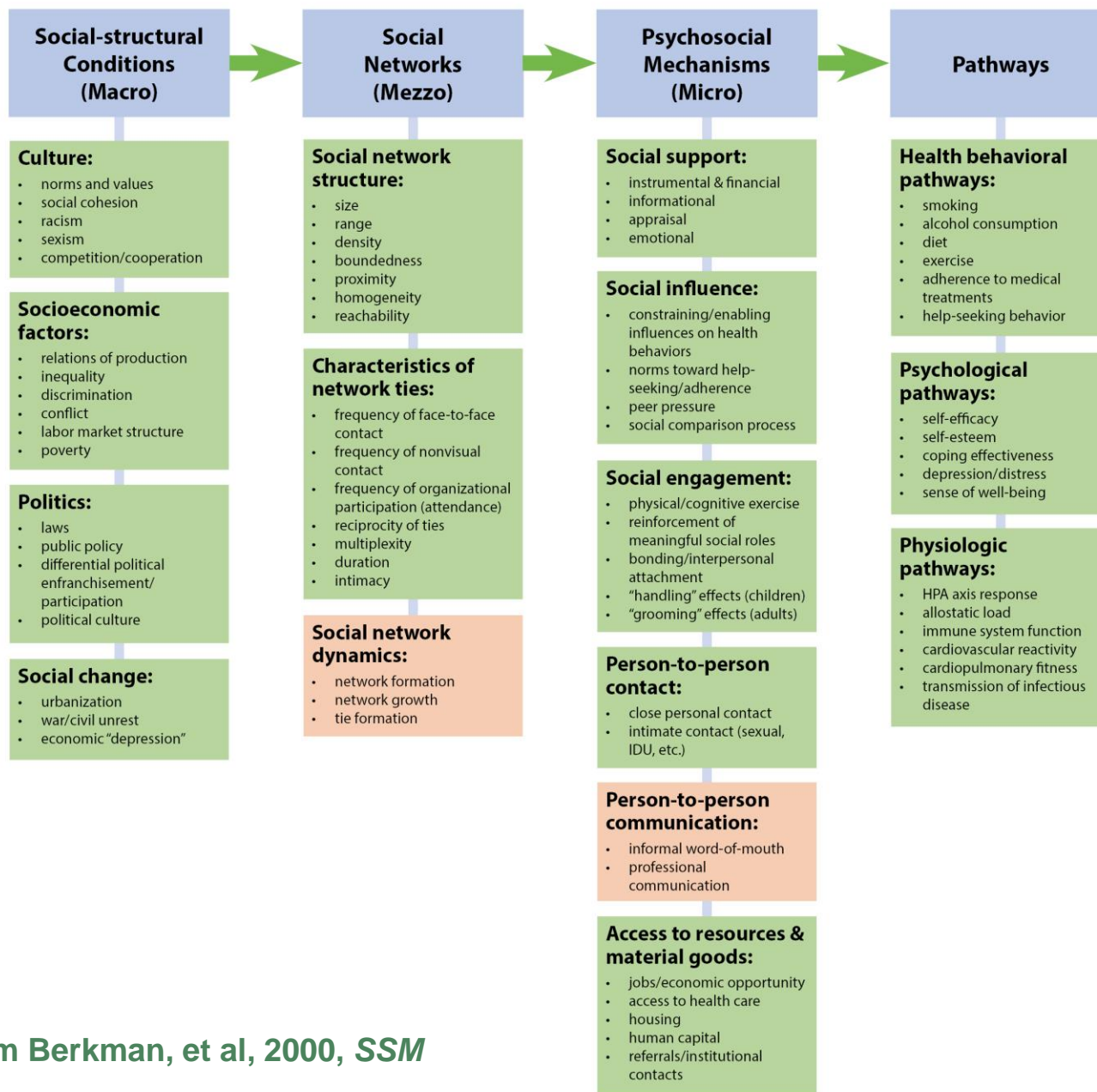
Organizational networks: LGBT Tobacco Control Network



What is the connection between social networks and health?

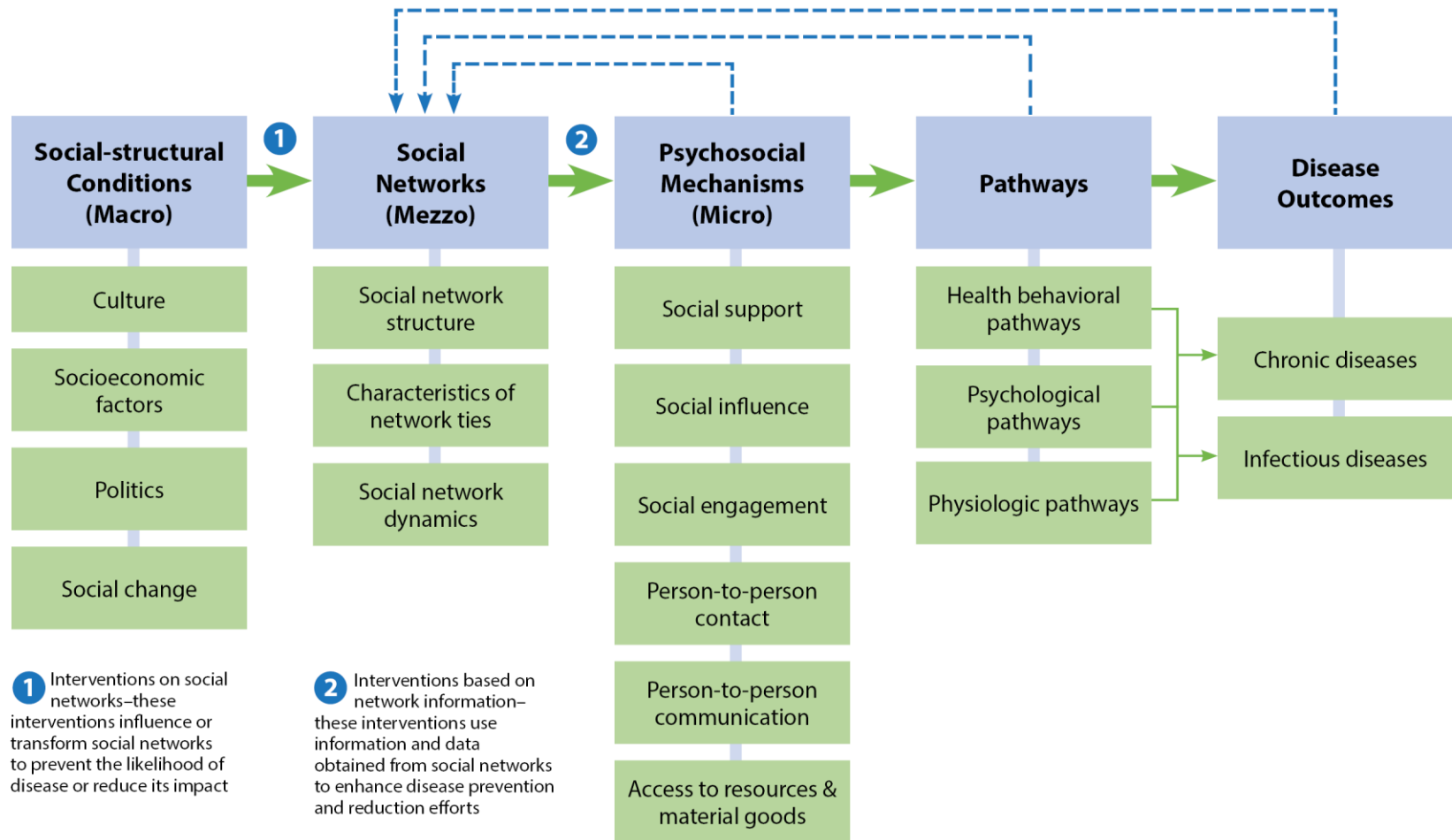
CONCEPTUAL MODEL

Social networks and human disease conceptual model



Adapted from Berkman, et al, 2000, *SSM*

Dynamic version of model



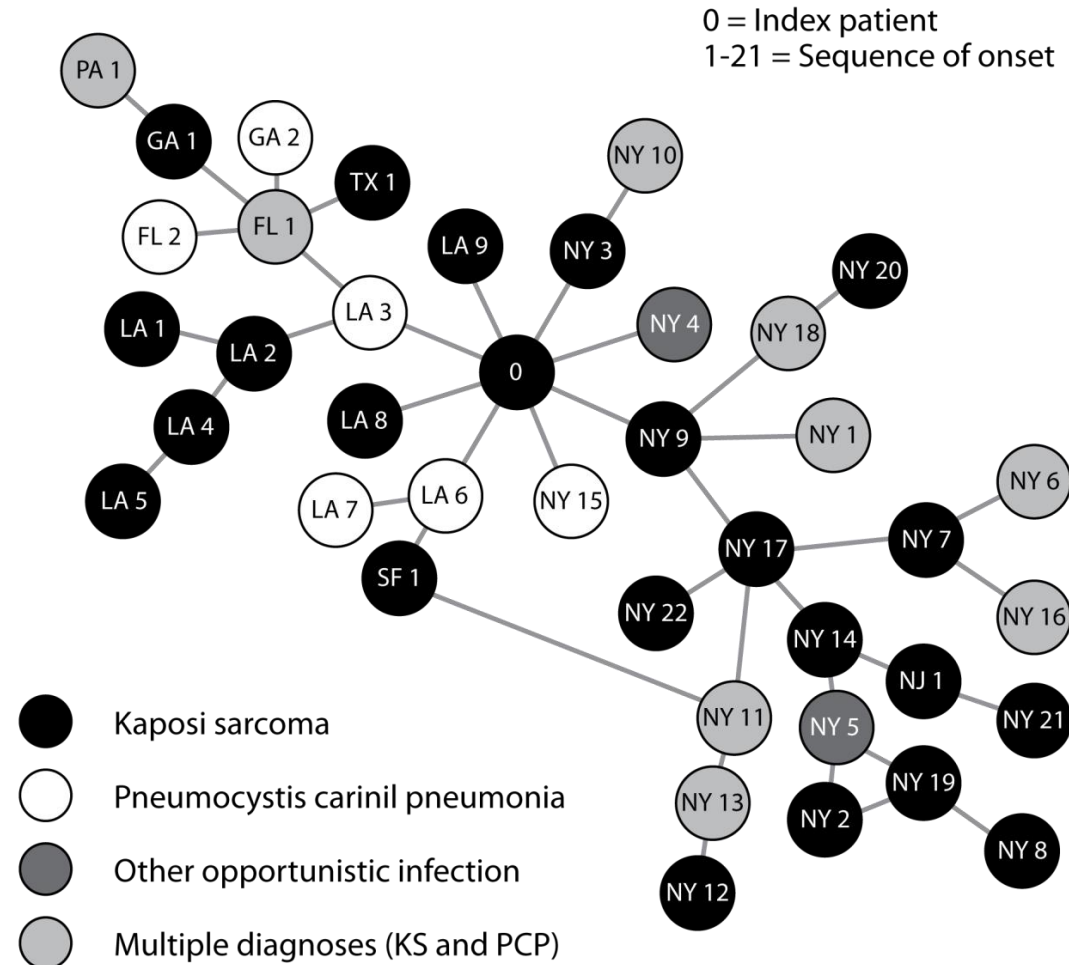
Social networks as environments that promote or inhibit health behavior and disease risk

HEALTH BEHAVIOR

Social networks implicated in chronic disease

- Primary prevention
 - Social networks related to wide variety of behavioral risk factors
 - Smoking, drinking, exercise, breast-feeding, etc.
- Secondary prevention
 - Peer and family networks can influence cancer screening
- Tertiary prevention
 - Numerous studies show that social support and size of social network increase life expectancy after cancer, heart disease, stroke

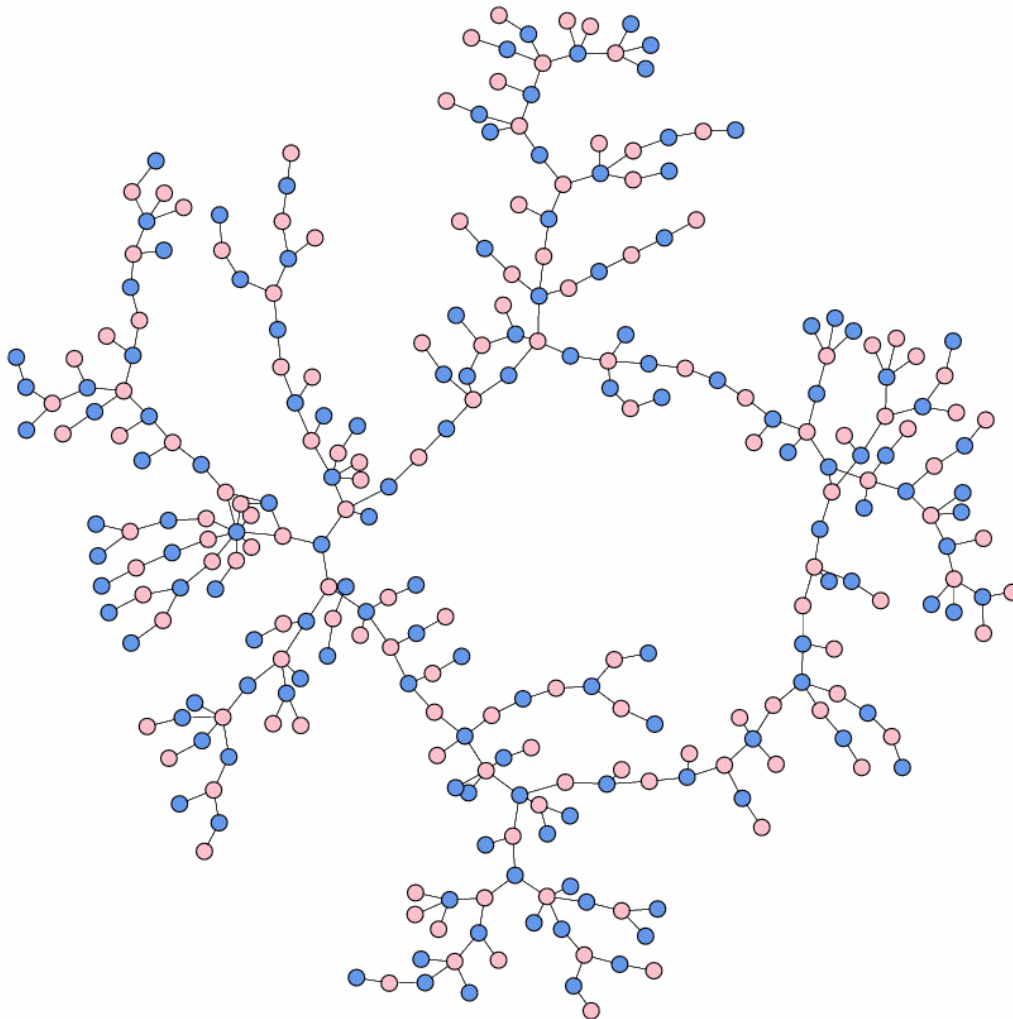
First HIV/AIDS network graphic



City LA-Los Angeles, NY-New York City, SF-San Francisco
State FL-Florida, GA-Georgia, NJ-New Jersey, PA-Pennsylvania, TX-Texas

(Auerbach et al, 1984; Luke & Stamatakis, 2012)

High school romantic contacts



Peter S. Bearman,
James Moody, and
Katherine Stovel,
Chains of affection:
The structure of
adolescent
romantic and
sexual networks,
American Journal
of Sociology 110,
44-91 (2004).

Social Networks, Social Support, and Survival After Breast Cancer Diagnosis

Candyce H. Kroenke, Laura D. Kubzansky, Eva S. Schernhammer, Michelle D. Holmes, and Ichiro Kawachi

Table 2. Relative Risk of Mortality by Category of Social Networks Prior to Diagnosis Among 2,835 Women With Breast Cancer From the Nurses' Health Study

Variables	Category of Social Networks				P*
	Socially Integrated (N = 1,315)	Moderately Integrated (N = 496)	Moderately Isolated (N = 826)	Socially Isolated (N = 198)	
All-cause mortality	106	28	66	24	
Age-adjusted					.17
No.	1.00	0.73	1.00	1.76	
95% CI		0.48 to 1.12	0.73 to 1.36	1.13 to 2.74	
Multivariate-adjusted†					.40
No.	1.00	0.73	0.93	1.66	
95% CI		0.48 to 1.11	0.68 to 1.28	1.04 to 2.65	
Breast cancer deaths	46	15	33	13	
Age-adjusted					.06
No.	1.00	0.87	1.22	2.04	
95% CI		0.48 to 1.55	0.78 to 1.91	1.10 to 3.78	
Multivariate-adjusted					.06
No.	1.00	0.91	1.24	2.14	
95% CI		0.50 to 1.68	0.78 to 1.98	1.11 to 4.12	

From Kroenke, 2006, *JCO*

Social Networks, Social Support, and Survival After Breast Cancer Diagnosis

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From Kroenke, 2006, JCO

Peer Group Structure and Adolescent Cigarette Smoking: A Social Network Analysis*

SUSAN T. ENNETT

Research Triangle Institute

KARL E. BAUMAN

University of North Carolina, Chapel Hill

Figure 1. Social Network Positions

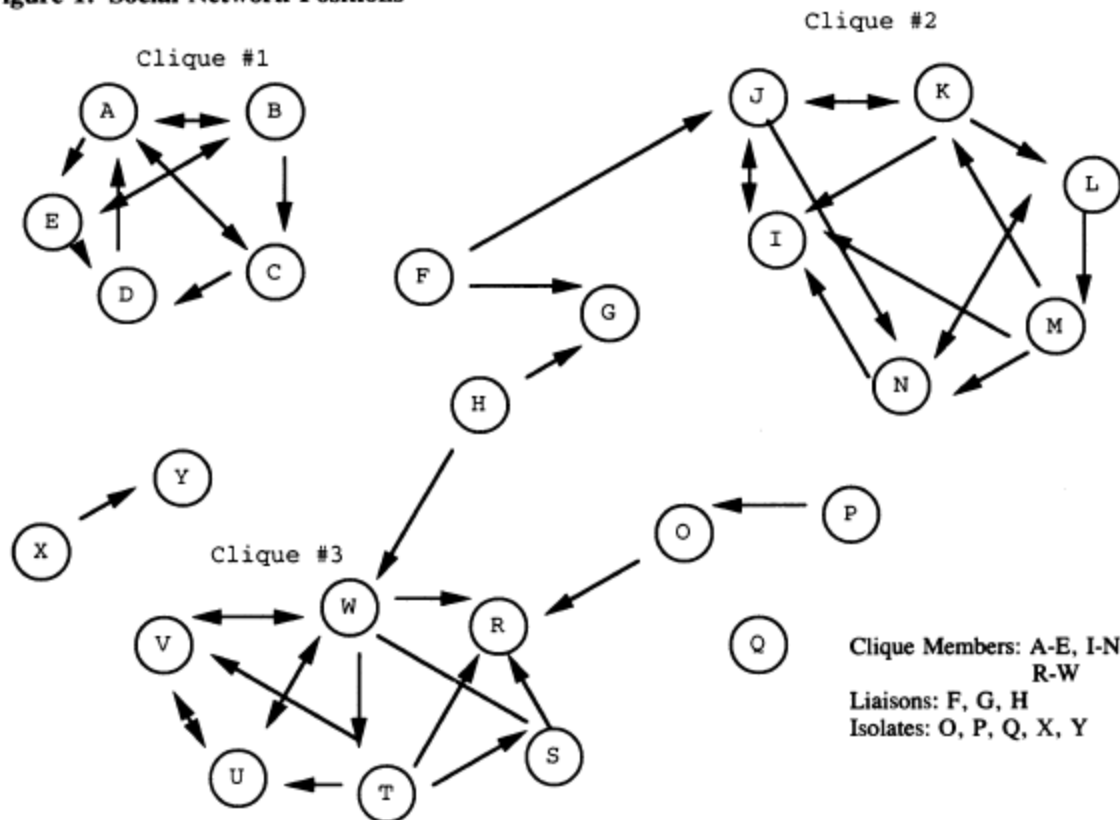


TABLE 3. Results of Logistic Regression Analysis of Current Smoking Status on Social Position, By School

	Adjusted Odds Ratio ^a	95% CI
School A (N=164)		
Network Isolate ^b	6.46***	2.08, 20.04
School B (N=164)		
Network Isolate	3.66***	1.67, 8.03
School C (N=257)		
Network Isolate	2.92***	1.54, 5.54
School E (N=288)		
Network Isolate and Male	6.05**	.81, 45.51
Network Isolate and Low Mother's Education	4.84*	1.37, 17.09

^a Adjusted for gender, race, and mother's education.

^b Reference is clique member/liaison.

* p < .05; ** p < .01; *** p < .001.

Peers, Schools, and Adolescent Cigarette Smoking

CHERYL ALEXANDER, Ph.D., MARINA PIAZZA, Sc.D., DEBRA MEKOS, Ph.D., AND
THOMAS VALENTE, Ph.D.

Table 2. Logistic Regression Analyses of Peer Variables Associated With Cigarette Smoking Among Adolescents*

Variable	Model 1 [†]			Model 2 [‡]		
	Odds Ratio	Adjusted SE	95% CI	Odds Ratio	Adjusted SE	95% CI
Peer network smoking (<50%)	1.07	0.11	0.88, 1.30	1.03	0.11	0.87, 1.30
Peer network smoking (≥50%)	1.91 [¶]	0.36	1.32, 2.78	1.89 [¶]	0.36	1.30, 2.75
Best friend smoking (one or both)	2.00 [¶]	0.19	1.67, 2.41	2.01 [¶]	0.19	1.66, 2.42
Popularity	1.02	0.07	0.90, 1.16	0.76	0.12	0.56, 1.03
School smoking prevalence [§]	1.73 [¶]	0.15	1.46, 2.06	1.49 [¶]	0.15	1.22, 1.82
Popularity [¶] school smoking prevalence				1.08 [‡]	0.04	1.01, 1.15

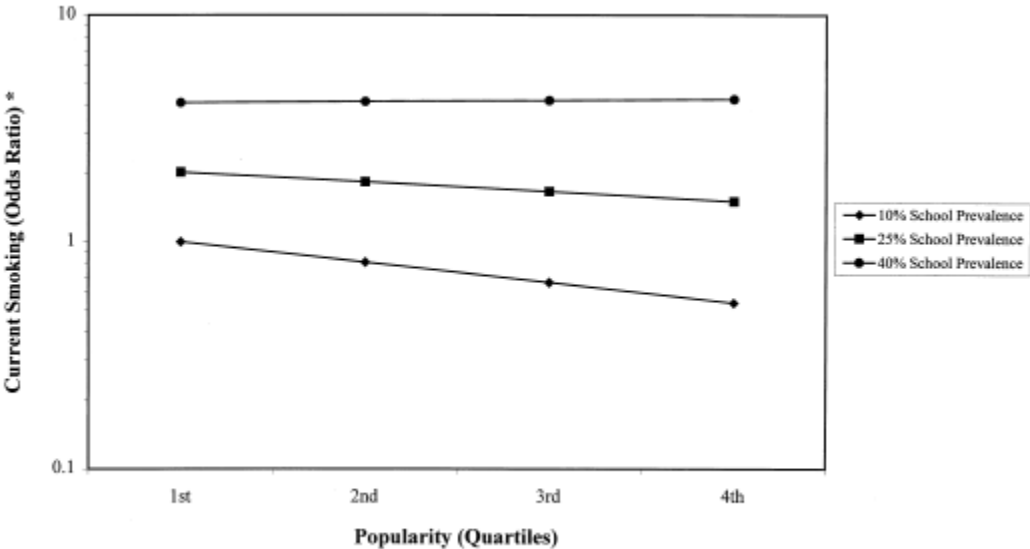


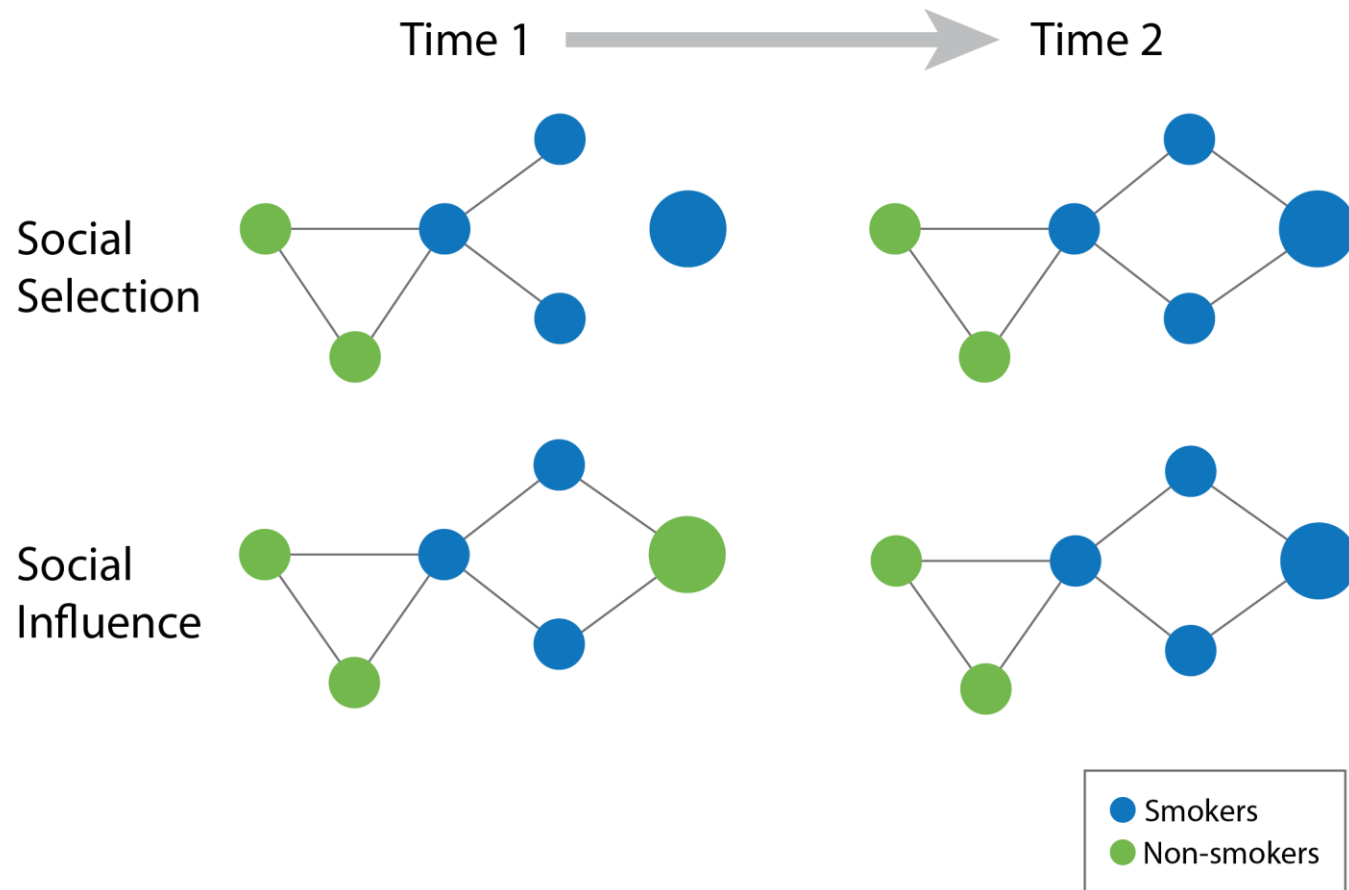
Figure 1. Interactive effect of popularity and school smoking prevalence on current smoking. (* Logarithmic scale.)

From Alexander, et al., 2001, *JAH*

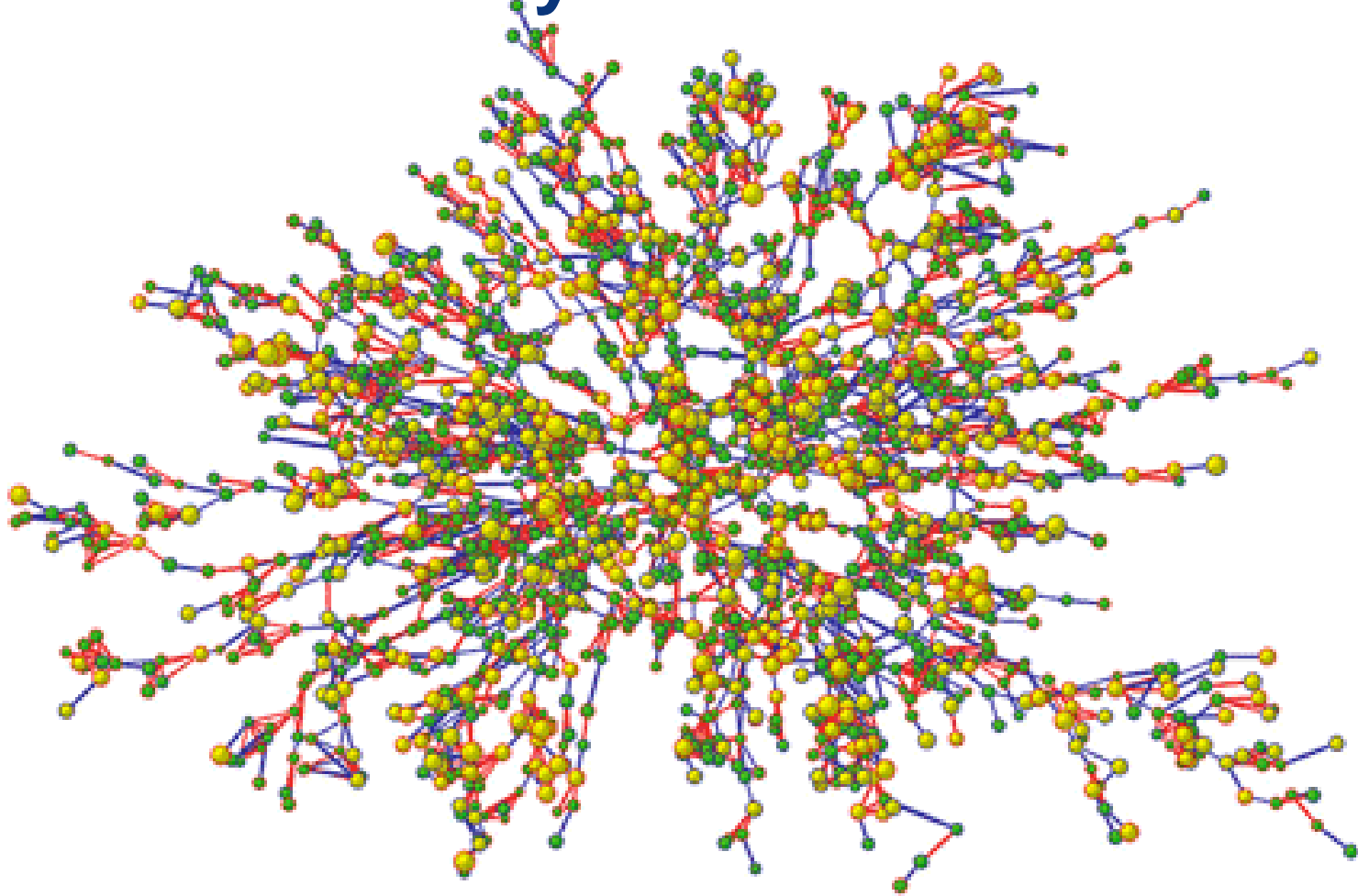
Theoretical challenge - Homophily

- Homophily – tendency for people who are connected in a network (e.g., friends) to be more similar to each other (e.g., smoking status); *Birds of a feather flock together*
- Challenge is to disentangle two potential causes of homophily
 - Social selection
 - Social influence

Underlying cause of homophily: Selection vs. influence



Disentangling peer influence and selection-obesity



Clustering of obesity (yellow circles) in a social network (Christakis & Fowler, 2007)

Smoking-based selection and influence in gender-segregated friendship networks: a social network analysis of adolescent smoking

Liesbeth Mercken^{1,2}, Tom A.B. Snijders^{3,4}, Christian Steglich⁴, Erkki Vertiainen⁵ & Hein de Vries^{1,2}

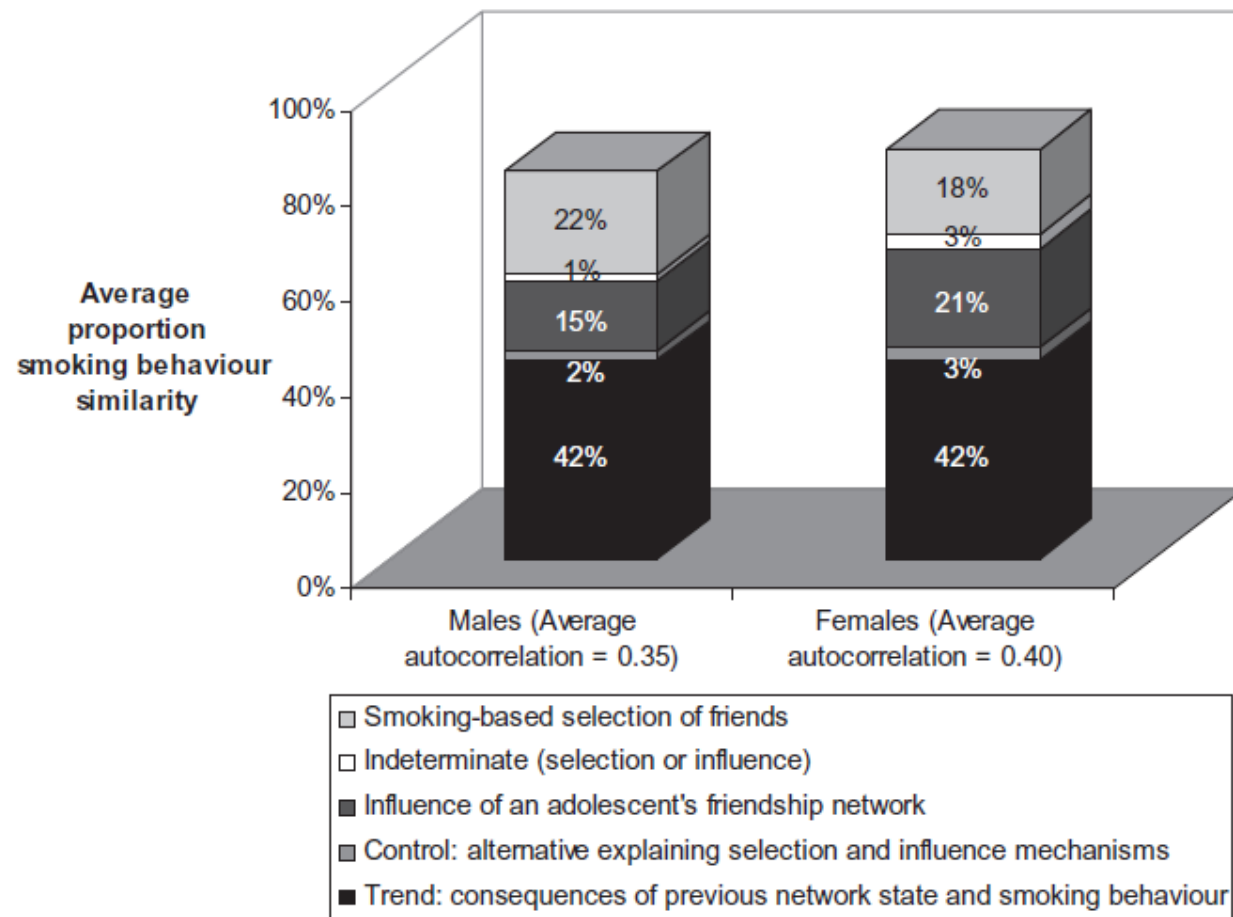


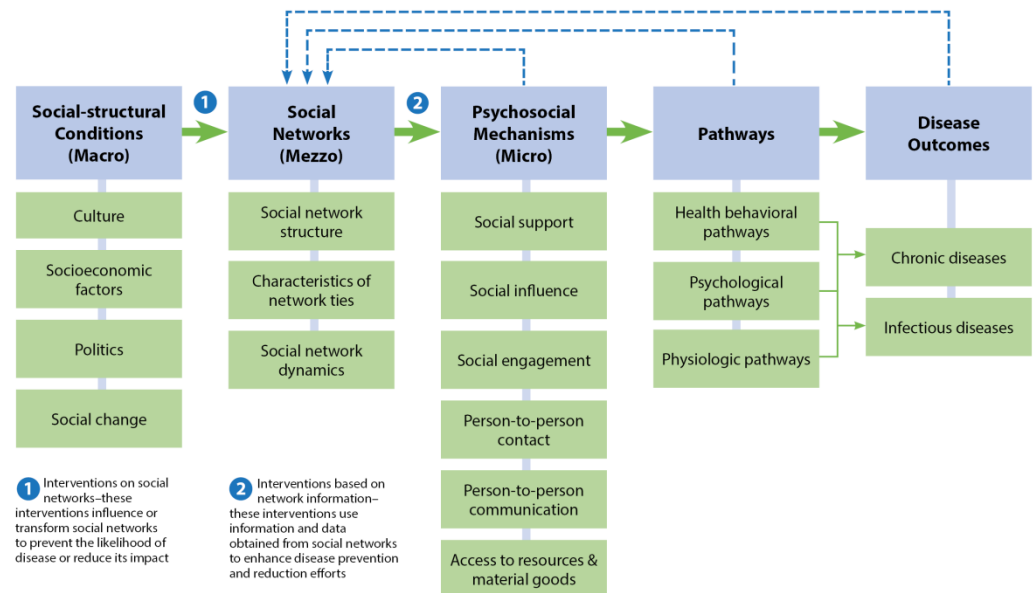
Figure 1 The relative contribution of smoking-based selection and influence on similarities in smoking. Note: the model explained 82% of smoking behaviour similarity among males, 87% among females

Developing more effective interventions and treatments that operate on social networks or use social network information

BEHAVIOR INTERVENTIONS

Disease interventions

- Conceptual model
- Two types
 - Direct intervention to the social network itself (1)
 - Use social network information to enhance an intervention or disease treatment (2)



Specific network intervention approaches (Valente)

- Identification of champions or opinion leaders
- Network segmentation
 - deliver intervention in specific network subgroups
- Network induction
 - use network to stimulate peer to peer interaction (e.g., word-of-mouth campaign)
- Network alteration
 - transform the network to promote health behavior

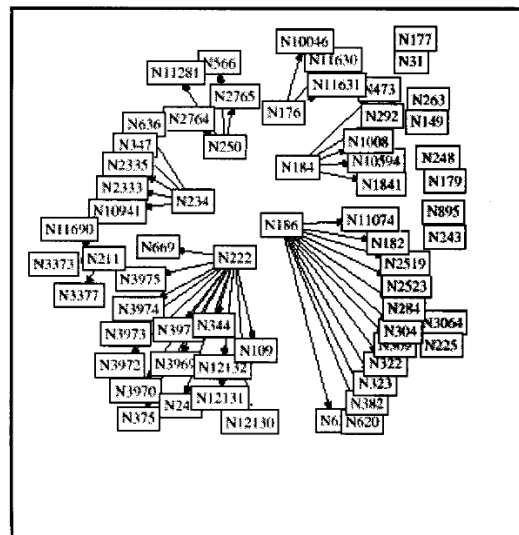
From Valente, 2012, *Science*.



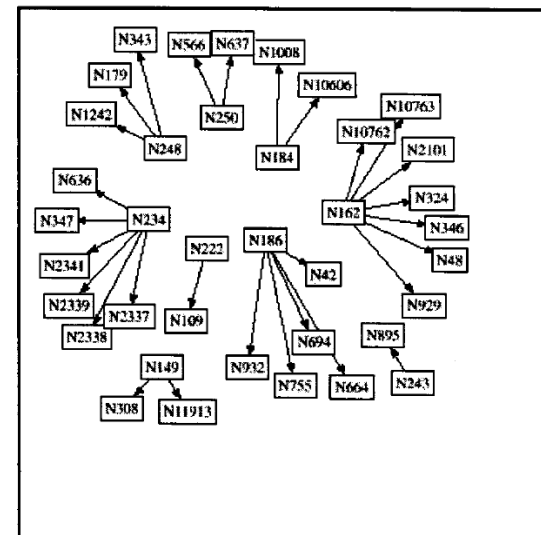
Original graphic by Jan Willem Tulp.
Based on Isella, 2011, *PLOS One*.

Can disease networks be modified?

Time 1



Time 2



Social network dynamics and HIV transmission

Richard B. Rothenberg, John J. Potterat*, Donald E. Woodhouse*, Stephen Q. Muth*, William W. Darrow† and Alden S. Klov Dahl†

Objective: To prospectively study changes in the social networks of persons at presumably high risk for HIV in a community with low prevalence and little endogenous transmission.

Methods: From a cohort of 595 persons at high risk (prostitutes, injecting drug users, and sexual partners of these persons) and nearly 6000 identified contacts, we examined the social networks of a subset of 96 persons who were interviewed once per year for 3 years. We assessed their network configuration, network stability, and changes in risk configuration and risk behavior using epidemiologic and social network analysis, and visualization techniques.

Results: Some significant decrease in personal risk-taking was documented during the course of the study, particularly with regard to needle-sharing. The size and number of connected components (groups that are completely connected) declined. Microstructures (small subgroups of persons that interact intensely) were either not present, or declined appreciably during the period of observation.

Conclusions: In this area of low prevalence, the lack of endogenous transmission of HIV may be related in part to the lack of a network structure that fosters active propagation, despite the continued presence of risky behaviors. Although the relative contribution of network structure and personal behavior cannot be ascertained from these data, the study suggests an important role for network configuration in the transmission dynamics of HIV. © 1998 Lippincott-Raven Publishers

AIDS 1998, 12:1529-1536

Keywords: HIV, social networks, transmission dynamics, injecting drug user, sexual activity

Time 3

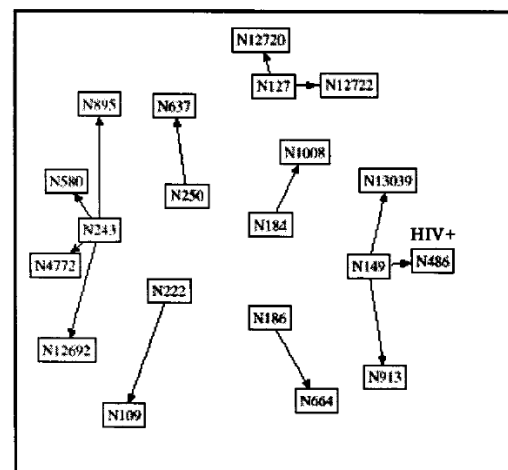


Fig. 2. Change in needle-sharing network of the 52 persons in cohort 2, each interviewed three times at 1-year intervals, demonstrating marked diminution in needle-sharing activity. At each interaction, the same 52 people were interviewed, and these diagrams depict those who said they shared needles and the contacts with whom they shared them.

Alcoholics Anonymous - best example of an effective network disease intervention

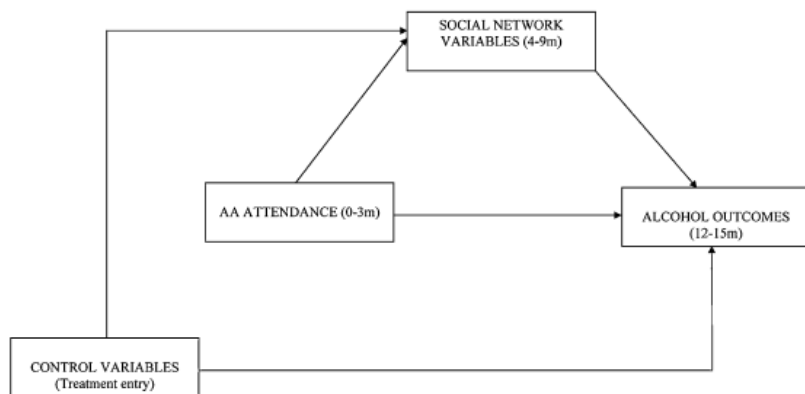


Fig. 1. Lagged mediational model.

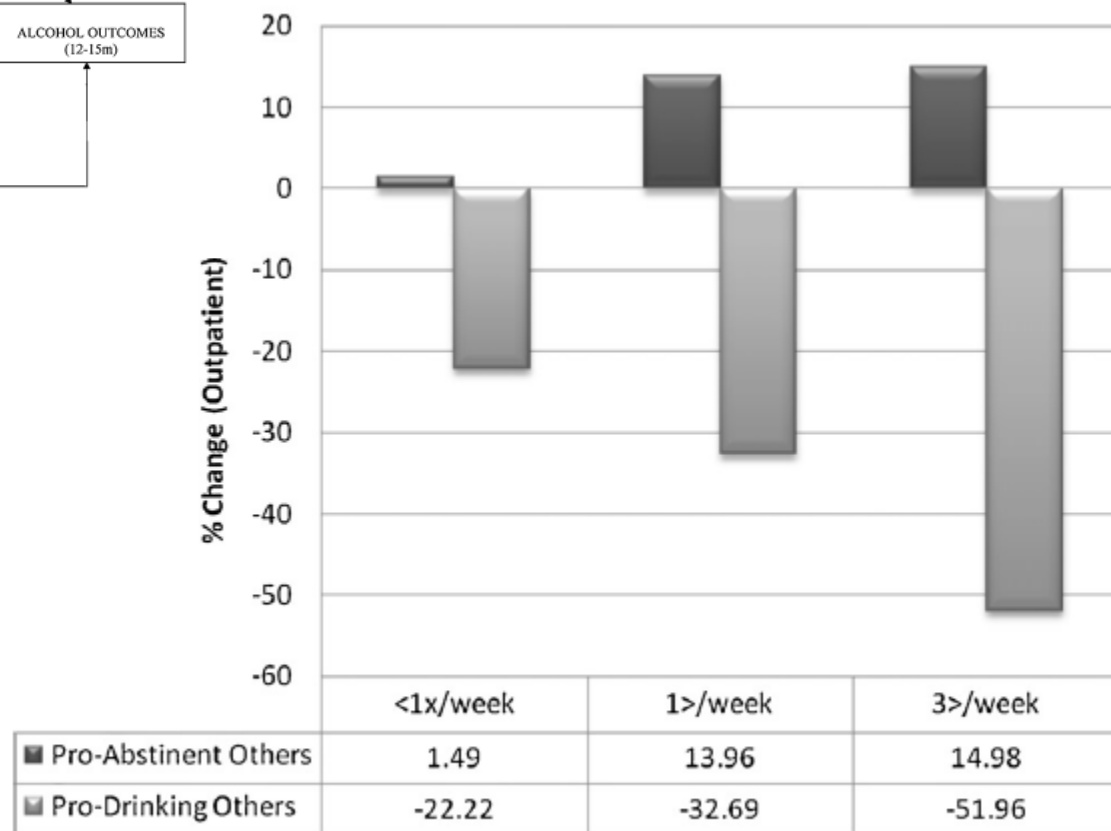


Fig. 2. Relationship between frequencies of AA attendance and changes in pro-abstinent and pro-drinking network ties.

Harnessing Peer Networks as an Instrument for AIDS Prevention: Results from a Peer-Driven Intervention

Figure 2. Recruitment network in a respondent-driven sample, beginning from a single "seed"

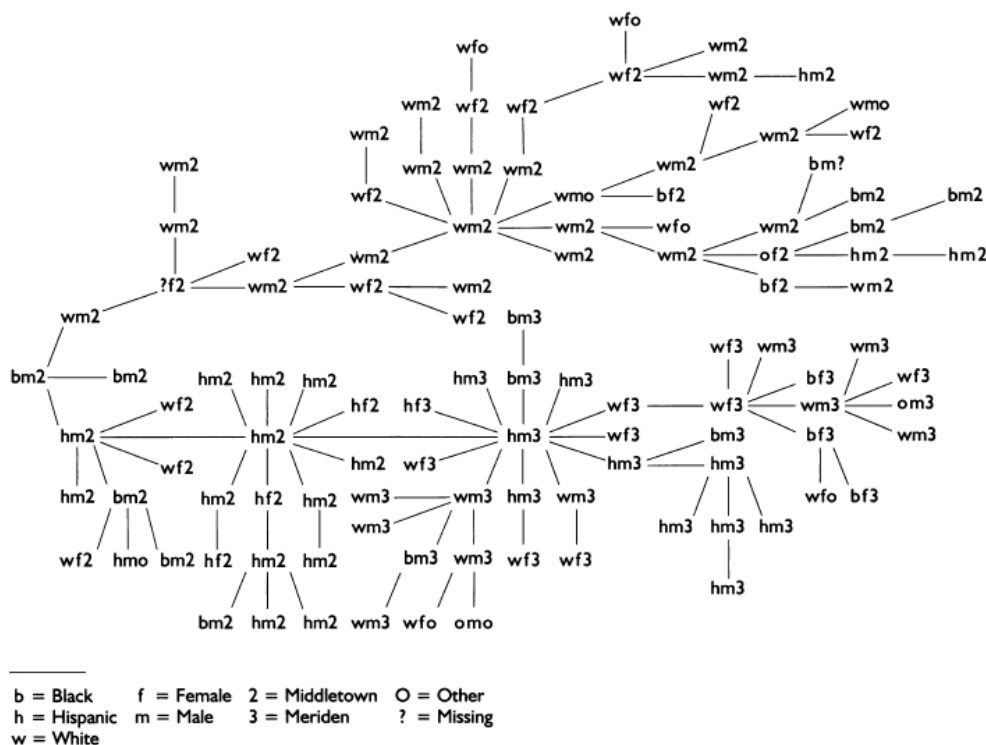
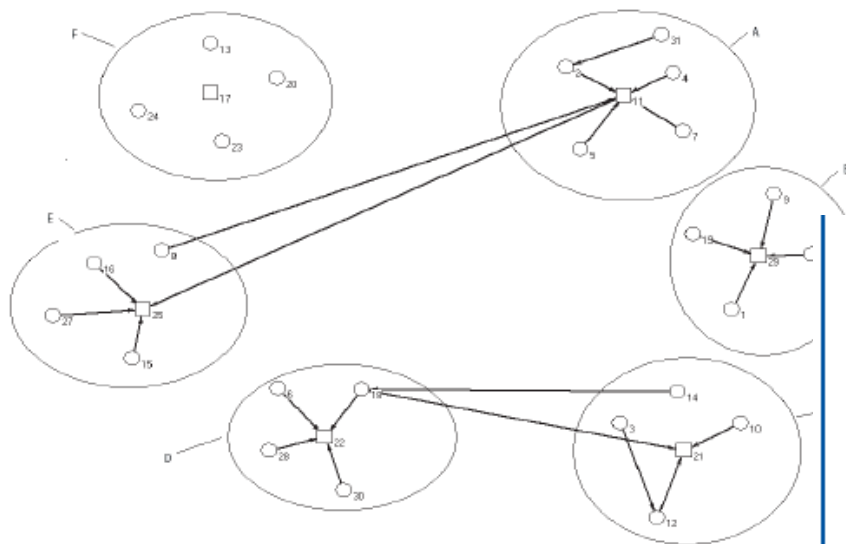


Table 5. Syringe sharing by site, first two years of operation

Percent reporting sharing behavior	Traditional outreach intervention (TOI)		Peer-driven intervention (PDI)			
	Initial (n = 223)	Follow-up (n = 135)	Middletown		Meriden	
			Initial (n = 149)	Follow-up (n = 60)	Initial (n = 146)	Follow-up (n = 49)
Syringe sharing						
Shared	17.0%	13.3%	12.8%	6.7%	23.3%	20.4%
Did not share	83.0%	86.7%	87.2%	93.3%	76.7%	79.6%
Reduction in sharing		22%		48%		12%
Chi-square	4.43		7.28		0.035	
df	1		1		1	
Level of significance	0.035		0.007		0.852	

Effects of a Social-Network Method for Group Assignment Strategies on Peer-Led Tobacco Prevention Programs in Schools

Thomas W. Valente, PhD, Beth R. Hoffman, MPH, Annamara Ritt-Olson, MA, Kara Lichtman, MA, and C. Anderson Johnson, PhD



Note. One hundred nineteen links are not shown because they did not result in group assignments.

FIGURE 1—Group assignments for 1 class.

TABLE 5—Classroom-Level Impact Estimates (β Coefficients) of Demographic, Smoking, and Study Condition Variables on Average Classroom Levels of Nonsmoking Attitudes, Self-Efficacy, Social Consequences of Smoking, and Intention to Smoke After Control for Precurriculum Levels (n = 84)

	Mean Smoking Attitude	Mean Self-Efficacy	Mean Social Consequences	Intention to Smoke
Pretest class average	0.67***	0.43***	0.71***	0.40***
Male	0.03	-0.10	-0.19	-0.09
Smoking prevalence	-0.02	0.19	0.13	-0.05
Hispanic/Latino	-0.46**	0.23	-0.27*	0.18
Asian American	0.19	-0.01	-0.04	-0.21
Ever puffed a cigarette	0.15**	0.12	0.07	0.09
Baseline data only	-0.26*	-0.15	0.08	-0.14
Tailored curriculum	0.12	-0.12	0.22	0.11
Teacher condition	0.01	-0.14	0.05	0.09
Network condition	-0.16*	-0.34***	-0.11	-0.31*
Teacher condition \times tailored curriculum	-0.13	0.18	0.02	0.16
Network condition \times tailored curriculum	0.14*	0.22	0.11	0.22
R ²	72%	46%	56%	57%

Note. Regression controls for intraschool covariation.

* $P < .05$; ** $P < .01$; *** $P < .001$.

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