

## Social Network Dynamics of Fast Food Consumption and Sedentary Activity Among Middle-School-Age Youth

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## Networks Are Everywhere

We live in a connected world (Facebook, Twitter)



- How do connections form?
  - Similar individuals become friends (selection)
- Once a network connection exists, how do we affect each other?
  - Connected individuals become increasingly similar over time (influence)
  - Certain voluntary behaviors (e.g., eating fast food, exercising) may be influenced by behaviors of close others

## Is Obesity “Contagious”?

Christakis & Fowler (NEJM, 2007) examined social network data from the Framingham Heart Study



- Linkages among over 12,000 individuals (relatives & friends), assessed repeatedly, 1971-2003
- Identified obesity clusters
- A cross-lagged panel model was used to identify selection and influence effects
  - An individual's chance of becoming obese increased by 57% if a friend became obese

## Intriguing Finding...but Controversial

Criticisms & critiques regarding statistical methods, causal interpretation, and mechanisms

- Cohen-Cole & Fletcher (J. Health Econ, 2008)
- R. Lyons ([//arxiv.org/abs/1007.2876](http://arxiv.org/abs/1007.2876))
- A. Gelman ([themonkeycage.org/blog/2011/06/10/](http://themonkeycage.org/blog/2011/06/10/))

Improvements in this study of middle school youth:

- Advanced modeling approach (Stochastic Actor-Oriented Modeling; e.g. Snijders et al., *Social Networks*, 2010) avoids network (spatial) autocorrelation
- Address *mechanisms* proximal to obesity

## Goals of the DyNet Project

- 1) Linking peer network affiliations (formation and dissolution) to behavior (development and change) among young adolescents (ages 12-14)
- 2) Modeling bi-directional relationships among affiliations and behavior using Stochastic Actor-Oriented Models (SAOMs)
- 3) Supporting development of RSiena, open-source software for estimating SAOMs (developed by Tom Snijders)

## DyNet Project Design

- A 3-year survey of 14 middle schools in the Western United States
- 4 web-based, in-school surveys per school year
- Participants nominated affiliates and best friends, and self-report behaviors over the previous 30 days

## Affiliates and Friends

- Participants nominated affiliates from a school-wide list of enrolled, non-opted-out students
- Definition of affiliates: spent “free time” with in the previous 30 days
  - “Free Time” = outside of class time or formal activities (school, sports, etc.)
- Affiliates could be “one of my best friends”
- Participants provided the number of days “free time” spent with each affiliate in the previous 30 days

## Affiliates and Friends (cont.)

- Participants could choose as many or as few affiliates and best friends as they wanted
- **Only best friend nominations** were considered for this analysis
- Participants choosing more than 25 best friends in a wave were identified as “outdegree outliers” and their best friend ties were recorded to missing. Indegrees and behavior were left intact.

## Our Study Goals

Examine social influence for behaviors theoretically proximal to obesity

- Diet: fast food consumption
- Diet: fruit/vegetable consumption
- Activity: vigorous exercise
- Activity: inactive pursuits (TV, video games, etc.)

Early adolescent sample

- Critical period for establishing healthy lifestyle



## Diet & Activity Measurement

- Data on diet and activity behaviors were collected for one middle school, for one school year (four waves) of the study
- 397 students completed at least one survey
  - Grades 6, 7 and 8
  - 54% Female
  - 63% White
  - 18% Latino
- Presenting fast food consumption and sedentary activity today. Analyses are ongoing for fruit and vegetable consumption and physical activity.

## Network Dynamics

Rate of change, W1-2	16.1437	Friendship ties change more rapidly at the beginning of the school year
Rate of change, W2-3	13.4762	
Rate of change, W3-4	12.2469	
Density	-3.5732 ***	
Reciprocity	1.4458 ***	
Transitive triplets	0.4729 ***	
3-cycles	-0.3156 ***	
Sex of Alter	-0.0612 *	
Same Sex	0.4189 ***	
Class of Alter	-0.1447 ***	
Class Similarity	1.8726 ***	
Same Race	0.1219 ***	
Latino Alter	0.2740 ***	
Same Ethnicity	0.1911 ***	
Density heterogeneity, W2-3	-0.2126 ***	
Density heterogeneity, W3-4	-0.3819 ***	

\*\*\* p < .001  
 \*\* p < .01  
 \* p < .05

## Network Dynamics

Rate of change, W1-2	16.1437	
Rate of change, W2-3	13.4762	
Rate of change, W3-4	12.2469	
Density	-3.5732 ***	-- Adolescents tend to selectively nominate friends
Reciprocity	1.4458 ***	-- Friendships tend to be mutual (high reciprocity)
Transitive triplets	0.4729 ***	-- Friends of friends become friends (positive transitivity)
3-cycles	-0.3156 ***	-- Hierarchies form (3-cycles are less likely, => hierarchical chains are more likely)
Sex of Alter	-0.0612 *	
Same Sex	0.4189 ***	
Class of Alter	-0.1447 ***	
Class Similarity	1.8726 ***	
Same Race	0.1219 ***	
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**Sex of Alter** -0.0612 \* -- Girls are more likely to be nominated as friends  
**Same Sex** 0.4189 \*\*\* -- Students tend to choose same-sex friends

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Density heterogeneity, W3-4	-0.3819	***

**Class of Alter** -0.1447 \*\*\* -- Between-grade choices are more likely to be higher-to-lower (vs. lower-to-higher)  
**Class Similarity** 1.8726 \*\*\* -- Students tend to choose friends closer to their own grade (same grade, or adjacent grade)

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**Same Race** 0.1219 \*\*\* Students are more likely to choose friends of their same race and ethnicity. Latino students are more likely to be chosen as friends compared to non-Latino students.

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**Density heterogeneity, W2-3** -0.2126 \*\*\* Most new ties are formed early in the school year  
**Density heterogeneity, W3-4** -0.3819 \*\*\*

### Fast Food Consumption

**Network Dynamics**

Fast Food Similarity	0.2503	**
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Students tend to choose friends with fast food consumption similar to their own (selection)

**Behavior Dynamics**

Rate of Change in Behavior, W1-2	4.2131	
Rate of Change in Behavior, W2-3	3.3610	
Rate of Change in Behavior, W3-4	2.2404	
Linear Shape of Behavior	0.0487	NS
Quadratic Shape of Behavior	0.1371	**
Fast Food Average Similarity	1.9417	NS (t = 1.94)



### Fast Food Consumption

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Fast Food Average Similarity	1.9417	NS (t = 1.94)

Changes in food consumption behavior are highest at the start of the school year

### Fast Food Consumption

**Network Dynamics**  
Fast Food Similarity 0.2503 \*\*

**Behavior Dynamics**  
Rate of Change in Behavior, W1-2 4.2131  
Rate of Change in Behavior, W2-3 3.3610  
Rate of Change in Behavior, W3-4 2.2404  
**Linear Shape of Behavior** 0.0487 NS  
Quadratic Shape of Behavior 0.1371 \*\*  
Fast Food Average Similarity 1.9417 NS (t = 1.94)

Consumption does not appear to follow a linear trajectory during the school year, but is increasing

### Fast Food Consumption

**Network Dynamics**  
Fast Food Similarity 0.2503 \*\*

**Behavior Dynamics**  
Rate of Change in Behavior, W1-2 4.2131  
Rate of Change in Behavior, W2-3 3.3610  
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Linear Shape of Behavior 0.0487 NS  
**Quadratic Shape of Behavior** 0.1371 \*\*  
Fast Food Average Similarity 1.9417 NS (t = 1.94)

Consumption does appear to positively reinforce itself during the school year

### Fast Food Consumption

**Network Dynamics**  
Fast Food Similarity 0.2503 \*\*

**Behavior Dynamics**  
Rate of Change in Behavior, W1-2 4.2131  
Rate of Change in Behavior, W2-3 3.3610  
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Linear Shape of Behavior 0.0487 NS  
Quadratic Shape of Behavior 0.1371 \*\*  
**Fast Food Average Similarity** 1.9417 NS (t = 1.94)

There is a borderline-significant, positive effect of friends' fast food consumption on students' own consumption (influence; p<.06)

### Sedentary Activity

**Network Dynamics**  
**Sedentary Activity Similarity** 0.0756 NS

Students don't seem to choose friends based on sedentary activity similar to their own

**Behavior Dynamics**  
Rate of Change in Behavior, W1-2 4.4895  
Rate of Change in Behavior, W2-3 4.2629  
Rate of Change in Behavior, W3-4 5.2702  
Linear Shape of Behavior 0.3902 \*\*\*  
Quadratic Shape of Behavior 0.2221 \*\*\*  
Sedentary Activity Avg. Sim 1.7003 NS

### Sedentary Activity

**Network Dynamics**  
Sedentary Activity Similarity 0.0756 NS

**Behavior Dynamics**  
Rate of Change in Behavior, W1-2 4.4895  
Rate of Change in Behavior, W2-3 4.2629  
Rate of Change in Behavior, W3-4 5.2702  
Linear Shape of Behavior 0.3902 \*\*\*  
Quadratic Shape of Behavior 0.2221 \*\*\*  
Sedentary Activity Avg. Sim 1.7003 NS

Changes in sedentary activity behavior are highest at the end of the school year

### Sedentary Activity

**Network Dynamics**  
Sedentary Activity Similarity 0.0756 NS

**Behavior Dynamics**  
Rate of Change in Behavior, W1-2 4.4895  
Rate of Change in Behavior, W2-3 4.2629  
Rate of Change in Behavior, W3-4 5.2702  
**Linear Shape of Behavior** 0.3902 \*\*\*  
Quadratic Shape of Behavior 0.2221 \*\*\*  
Sedentary Activity Avg. Sim 1.7003 NS

Sedentary activity appears to follow an upward linear trajectory during the school year

## Sedentary Activity

### Network Dynamics

Sedentary Activity Similarity 0.0756 NS

### Behavior Dynamics

Rate of Change in Behavior, W1-2 4.4895

Rate of Change in Behavior, W2-3 4.2629

Rate of Change in Behavior, W3-4 5.2702

Linear Shape of Behavior 0.3902 \*\*\*

Quadratic Shape of Behavior 0.2221 \*\*\*

Sedentary Activity Avg. Sim 1.7003 NS

Sedentary activity also appears to positively reinforce itself during the school year

## Sedentary Activity

### Network Dynamics

Sedentary Activity Similarity 0.0756 NS

### Behavior Dynamics

Rate of Change in Behavior, W1-2 4.4895

Rate of Change in Behavior, W2-3 4.2629

Rate of Change in Behavior, W3-4 5.2702

Linear Shape of Behavior 0.3902 \*\*\*

Quadratic Shape of Behavior 0.2221 \*\*\*

Sedentary Activity Avg. Sim 1.7003 NS

The model did not find evidence of influence of friends' sedentary activity on students' own behavior

## Discussion

- We find evidence for both selection and influence effects for fast food consumption
  - Consuming more fast food predicts obesity in adolescents and adults (Pereira et al., 2005; Kestelhoot & Joosens, 1992; McCrory et al., 1999; Troiano et al., 2000)
  - Selection AND influence effects suggest a **problem-feedback loop** (friends ⇔ fast food consumption)
  - May partly explain positive quadratic pattern (accelerates over the school year)

## Discussion

- Although students increased rates of sedentary activity over the school year, we found no evidence of selection or influence effects on sedentary activity
  - May be too common among young adolescents to be a predictor of behavior or a basis for friendship
  - Perhaps a more meaningful measure would be required to identify harmful effects
- May be illuminating to examine physical activity... analyses in progress

## Conclusion

- We offer new evidence for one potential mechanism for network-based obesity "contagion": exposure to friends who frequent fast food restaurants
  - There is also evidence that friendship selection is based on such behavior
  - ...and this may provide reinforcement for further escalation
- This inference is not ironclad, but improves on previous research in several important ways

Thank you!



## References

- Christakis, N. A. & Fowler, J. H. (2007). The spread of obesity in a large social network over 32 years. *New England Journal of Medicine*, 357, 370-379.
- Cohen-Cole, E. & Fletcher, J. W. (2008). Is obesity contagious? *Journal of Health Economics*, 27, 1382-1387.
- Kesteloot H, Joossens JV. Nutrition and international patterns of disease. In: Marmot M & Elliott P (eds). *Coronary disease epidemiology: from aetiology to public health*. Oxford University Press: New York; 1992. pp 152 – 165. \*\*USE MORE RECENT?
- McCrary MA, Fuss PJ, Hays NP, Vinken AG, Greenberg AS et al. Overeating in America: association between restaurant food consumption and body fatness in healthy adult men and women ages 19 to 80. *Obes Res* 1999; 7: 564 – 571.
- Troiano RP, Briefel RR, Carroll MD, Bialostosky K. Energy and fat intake of children and adolescents in the United States. Data from the National Health and Nutrition Examination Surveys. *Am J Clin Nutr* 2000; 72(Suppl): 1343s – 1353s.
- Snijders, T. A. B., van de Bunt, G. G., & Steglich, C. E. G. (2010). Introduction to stochastic actor-based models for network dynamics. *Social Networks*, 32, 44-60.