Social Network Concordance in Food Choice Among Spouses, Friends, and Siblings

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Objectives. We investigated whether eating behaviors were concordant among diverse sets of social ties.

Methods. We analyzed the socioeconomic and demographic distribution of eating among 3418 members of the Framingham Heart Study observed from 1991 to 2001. We used a data-classification procedure to simplify choices into 7 nonoverlapping patterns that we matched with information on social network ties. We used correlation analysis to examine eating associations among 4 types of peers (spouses, friends, brothers, and sisters). Longitudinal multiple logistic regression was used to evaluate evidence for peer influences on eating.

Results. Of all peer types, spouses showed the strongest concordances in eating patterns over time after adjustment for social contextual factors. Across all peers, the eating pattern most likely to be shared by socially connected individuals was ''alcohol and snacks.'' Models estimating one's current eating pattern on the basis of a peer's prior eating provided supportive evidence of a social influence process.

Conclusions. Certain eating patterns appeared to be socially transmissible across different kinds of relationships. These findings represent an important step in specifying the relevant social environment in the study of health behaviors to include eating. (*Am J Public Health.* 2011;101:2170–2177. doi:10.2105/AJPH.2011.300282)

Food consumption is incontrovertibly linked with public health outcomes ranging from obesity to cardiovascular disease and diabetes.[1,2] Research has found that eating with others affects what an individual consumes[3] and, more recently, that obesity status is influenced by ties in social networks.[4] Together, this knowledge highlights the value of understanding the roles that relationships play in our eating behaviors. To date, however, there has been little research investigating the relationship between patterns of food consumption and the complex patterns of human connectedness. To what degree is the eating behavior of one's peers associated with what one eats?

Research on commensality and health concordance gives some insight into this question. For instance, eating with others is associated with greater ingestion than when food is consumed alone[5]; friends and family members are associated with greater "social facilitation" than are other kinds of relationships, including co-workers, classmates, lovers, or roommates[3]; family members are more likely to eat together than friends are[6]; and cognitive dietary restraint, disinhibition, and susceptibility to hunger have a significant familial resemblance.[7] Research on diet in the context of health concordance has found that newly coupled individuals tend to increase their consumption of fruits and vegetables, low-fat foods, and breakfasts together, while consuming less take-out food,[8] and that spouses' nutrient consumption is modestly correlated.[9] Couples shape one another's choices, although female partners tend to have more influence over male choices.[10] However, a great deal of what we know of commensality has been gleaned from laboratory research rather than real-world studies of eating behavior, thereby excluding the social environment. Similarly, our knowledge of diet concordance in observational studies has largely issued from small-scale, cross-sectional designs.[11]

Previous work on social networks and health has found that weight status is related to patterns of social relations[4,12] and that drinking behaviors can spread in a social network.[13] However, whether food consumption per se is subject to similar forms of peer influence in a network setting has not been examined. Our objective was to investigate whether connections with particular kinds of intimate relations (spouses, friends, and siblings) were predictive of eating patterns of connected individuals in a large prospective cohort study over time. To address this question, food patterns were first enumerated from food-frequency questionnaires. We then performed a series of correlation analyses to assess food pattern concordance, and we fit a series of longitudinal multiple logistic regression models to test for peer influence on eating among close social contacts.

METHODS

We studied 3799 participants from the well-known Framingham Heart Study. Members of the Offspring Cohort were enrolled in 1971 (examination 1). The present study examined men and women in this cohort during a more recent period, between 1991 and 2001: examination 5 was administered from 1991 to 1995, examination 6 from 1995 to 1998, and examination 7 from 1998 to 2001. Approximately 90% (n=3418) of these individuals had usable food-choice data at examination 5, 89% (n=3143) had usable data at examination 6, and 86% (n=3030) had usable data at examination 7. Attrition of 275 individuals between examinations 5 and 6 was largely the result of survey nonresponse at examination 6; 27 cases were lost because of mortality. Attrition of 113 individuals between examinations 6 and 7 was again largely the result of nonresponse; 15 cases were lost to mortality. The primary data-collection protocols were approved by the institutional review board at Boston University; the procedures and protocols for this study were approved by the institutional review boards at Harvard University Faculty of Arts & Sciences and Harvard Medical School.

Measures

We exploited 3 sources of data: information on food consumption, information on the presence and nature of social ties among individuals, and socioeconomic and demographic information. Food-consumption data were gathered for a large majority of the cohort members examined between 1991 and 2001. Self-reports on consumption of standardized amounts of 127 foods were gathered with a semiquantitative food-frequency questionnaire (1988-GP version) developed and validated by Willett et al.[14,15] We used these foods as input variables to enumerate a set of nonoverlapping food patterns that described how the cohort ate. At each measurement, an individual was described by only 1 of these patterns, as described below.

We used sociodemographic information to help control for confounding in education (from 2 to 17 years), occupational prestige (a continuous measure on the Treiman scale from 13 to 78), gender (dichotomous, men or women), and age (continuous, from 26 to 89 years). We included several covariates to control for diet context, including continuous body mass index (BMI; defined as weight in kilograms divided by the square of height in meters), a summary measure of standardized servings per week of food as measured by the food-frequency questionnaire, and diet diversity (a continuous measure ranging from 7 to 40 of how many distinct food groups were consumed). In the case of missing observations, we used listwise deletion to omit cases. This solution limited our capabilities for inference, but it enabled us to avoid the imputation of missing data, which, although useful in some instances, is especially complicated (and tenuous) in the case of an individual who reports eating more than 100 individual foods.

We enumerated social ties among individuals by using the Framingham Heart Study network database (FHS-net) described elsewhere.[4] Briefly, we coded administrative records that listed a cohort member's close social contacts to indicate the presence of a social tie between the cohort member (ego) and a contact (alter). We also recorded information on the type of relationship (friend, family member, spouse). Using geocoded location data, we included a continuous variable that indexed physical proximity (in miles) between ego and alter, which allowed us to control for the influence of distance. Among spouses, we operationalized distance by using an indicator variable for cohabitation; in 91.4% of cases, spouses cohabited. Among friends and siblings, a distinction was made between alters who lived in close proximity (within 10 miles of one another) and those who lived farther away (more than 10 miles from each other). Among egos and friends, 76.7% lived within 10 miles of one another. Among siblings, 42.9% of egos and brothers lived within 10 miles, and 40.5% of egos and sisters lived within a 10-mile radius.

We included 2 network measures in the models[16]: "degree" measured the number of people connected to an ego, whereas "betweenness centrality" measured how central or peripheral an ego was in the network of all connected individuals.[17] Betweenness centrality is exogenous to individual reports. That is, a person can know how many contacts he or she has nominated without knowing their location within the network as a whole.

Analysis of Food Patterns

We used a multistage procedure to enumerate food patterns for each individual in the Offspring Cohort. Because no clear agreement exists on which single method is best for analyzing diet patterns, we have carefully outlined our analytic goals and enumeration procedure, as a recent review advocates.[18] (More details of this analysis, including measurement diagnostics, are described and reported in Tables A–C; Appendix available as a supplement to the online version of this article at http://www.ajph.org.)

Our objective was to construct a variable that could represent, in a simple fashion, how an individual eats. Furthermore, we required that this measure be amenable to analysis within a longitudinal framework. Existing analysis protocols (e.g., in the epidemiological literature) typically rely on factor (principal components) analysis or cluster analysis to enumerate a small number of eating types that can describe a population at a point in time. Yet these types are typically incommensurable across repeated measures because a unique (and incomparable) set of factors would otherwise be developed at each snapshot.

To address this issue, we first pooled repeated food-frequency measurements spanning examinations 5 to 7 before a factor analysis (by using a principal component factor method) so we could determine a single set of factors describing all observations (n=9591). Then, we ascertained an individual's eating pattern by using cluster analysis in reference to the range of possibilities exhibited in the data. These pooled observations were then redistributed to their proper panel, yielding a comparable set of patterns across all 3 points in time (examination 5, n=3418; examination 6, n=3143; examination 7, n=3030).

Seven types of food patterns were enumerated by use of this procedure. Individuals captured by the "meat and soda" pattern ate more animal proteins and sweetened caffeinated beverages. "Sweets" eaters consumed more sugary products, high-fat dairy products, and refined grains. Those captured by the "alcohol and snacks" pattern consumed disproportionate amounts of these items relative to peers. "Light eaters" had notably lower levels of vegetables and fruits, grains, and several kinds of desserts, and their mean weekly consumption (92.5 $\pm$21.6 servings/week) was notably lower than was that of their cohort peers (159.6 $\pm$53.6 servings/week). Separate analysis showed that this was not the result of underreporting; rather the cause was low levels of consumption for many items. People with the "caffeine-avoidant" pattern consumed more caffeine-free soda (both full and low-calorie) and decaffeinated coffee. Those with the "offsetting" pattern had high levels of snacks and low-fat sweets, but they also consumed comparatively high levels of whole grains, nonfat dairy beverages, and high-fat healthier foods such as nuts and peanut butter. "Healthier" eaters consumed the highest levels of fruits and vegetables, low-fat poultry, fish, and legumes. The names assigned to the foregoing 7 categories are obviously artificial, but the categorization itself is empirical.

We also examined the 7 food patterns in terms of their mean scaling on an external measure of diet health to help validate and describe the patterns. The Dietary Guidelines Adherence Index (DGAI), a continuous scale from 1.0 to 20.0, takes into account both energy-specific food intake recommendations and healthy choice nutrient recommendations advocated in the sixth edition of the *Dietary Guidelines for Americans*.[19]

Statistical Analysis

Associations between the ego's food patterns and those of the 4 types of alter (spouse, friend, brother, sister) were first reported by using

TABLE 1—Descriptive Statistics of the Study Cohort: Framingham Heart Study Offspring Cohort, 1991–2001

	Meat and Soda		Sweets		Alcohol and Snacks		Light Eaters		Caffeine-Avoidant		Offsetting		Healthier		
	No.	Mean ±SD (Range) or %	No.	Mean ±SD (Range) or %	No.	Mean ±SD (Range) or %	No.	Mean ±SD (Range) or %	No.	Mean ±SD (Range) or %	No.	Mean ±SD (Range) or %	No.	Mean ±SD (Range) or %	*P* for Trend
Gender															<.001
Men	860	57.6	428	52.8	810	62.4	384	42.0	464	42.5	781	47.9	723	30.8	
Women	634	42.4	383	47.2	488	37.6	531	58.0	629	57.6	850	52.1	1626	69.2	
Age, y	1494	54.2 ±9.9	811	58.7 ±10.4	1298	57.5 ±9.1	915	58.9 ±9.8	1093	57.9 ±9.2	1631	60.1 ±10.3	2349	59.0 ±9.9	<.001
		(29–85)		(26–85)		(31–84)		(30–89)		(33-83)		(30–86)		(28-87)	
BMI, kg/m^2	1489	28.1 ±5.5	809	28.1 ±5.1	1293	27.8 ±4.6	912	27.8 ±5.1	1091	28.6 ±5.4	1624	27.4 ±4.9	2341	27.4 ±5.2	<.001
		(15.2–53.4)		(17.1–54.3)		(18.1–58.2)		(17.6–54.8)		(17.7–52.2)		(15.9–53.5)		(14.4–64)	
Education, y	1236	13.4 ±2.27	723	13.8 2.3	1109	14.1 ±2.3	786	13.5 ±2.1	933	13.7 ±2.2	1466	14.0 ±2.2	1979	14.1 ±2.2	<.001
		(4–17)		(4–17)		(2–17)		(7–17)		(6–17)		(7–17)		(2–17)	
Job prestige	1071	47.2 ±12.0	506	48.4 ±11.8	781	50.2 ±12.6	537	47.4 ±13.0	683	48.8 ±11.9	842	49.2 ±12.2	1370	50.7 ±11.3	<.001
		(13–78)		(13–78)		(15–78)		(13–78)		(13–78)		(15–78)		(15–78)	
Servings of food/wk	1494	176.3 ±55.7	811	177.6 ±55.0	1298	164.7 ±47.9	915	92.5 ±21.6	1093	161.3 ±50.2	1631	177.2 ±50.2	2349	153.0 ±45.2	<.001
		(59.0–746.3)		(51.7–495.1)		(63.2–374.8)		(33.0–172.0)		(54.9–385.4)		(66.0–398.3)		(48.4–407.8)	
Diversity of diet	1494	29.59 ±3.8	811	30.9 ±3.5	1298	30.3 ±4.0	915	27.4 ±3.9	1093	29.3 ±3.9	1631	29.0 ±3.6	2349	29.2 ±3.9	<.001
		(9–40)		(18–40)		(14–40)		(14–39)		(11–40)		(12–40)		(15–39)	
DGAI score (range = 1–20)	1366	7.29 ±2.11	751	8.03 ±2.27	1171	8.31 ±2.24	825	8.36 ±1.89	995	9.41 ±2.41	1482	9.7 ±2.28	2094	12.0 ±1.94	<.001
		(2.5–14)		(2–16)		(2–15.5)		(3.5–13.8)		(2.8–15.3)		(3.5–15.5)		(5.5–17.5)	
Social network distance of ego/alter															
Degree (no. of friends)	1385	5.58 ±5.49	745	5.48 ±5.49	1180	5.06 ±4.74	849	5.34 ±5.23	1040	5.21 ±5.07	1548	5.10 ±4.82	2160	5.05 ±4.97	.032
		(0–38)		(0–39)		(0–32)		(0–33)		(0–32)		(0–39)		(0–35)	
Betweenness centrality	1385	0.06 ±0.21	811	0.07 ±0.22	1180	0.05 ±0.15	915	0.07 ±0.27	1040	0.05 ±0.17	1548	0.05 ±0.18	2160	0.05 ±0.16	.012
(scaled ×100)		(0–3.48)		(0–3.39)		(0–2.02)		(0–4.93)		(0–2.10)		(0–3.24)		(0–2.36)	
Physical distance of ego/alter															
Cohabits with spouse	670	91.4	419	93.5	654	89.3	523	93.2	591	93.0	912	93.6	1112	91.3	.023
Does not cohabit with spouse	63	8.6	29	6.5	78	10.7	38	6.8	45	7.0	63	6.5	106	8.7	
Friend < 10 miles	154	81.9	125	80.7	161	70.6	119	78.3	144	78.3	193	80.4	267	77.2	.106
Friend ≥ 10 miles	34	18.1	30	19.4	67	29.4	33	21.7	40	21.7	47	19.6	79	22.8	
Brother < 10 miles	283	45.3	175	52.6	192	38.8	175	48.3	212	48.3	261	41.3	353	40.1	<.001
Brother ≥ 10 miles	342	54.7	158	47.5	303	61.2	172	51.7	227	51.7	371	58.7	527	59.9	
Sister < 10 miles	287	41.2	160	47.3	219	40.6	199	51.4	178	42.5	271	40.9	358	37.5	<.001
Sister ≥ 10 miles	409	58.8	178	52.7	320	59.4	198	48.6	241	57.5	392	59.1	596	62.5	

Note. BMI = body mass index; DGAI = Dietary Guidelines Adherence Index. Alter refers to a contact while ego refers to a cohort member. Observations are pooled from examinations 5 to 7. Trends across gender and alter/ego physical distance were evaluated by χ^2 test; all other continuous covariates were evaluated by using the *F* test.

Pearson correlations and χ^2 associations. We then estimated a series of longitudinal random (mixed) effects logistic regression models in which the outcome of interest was a binary measurement of the ego's food patterns. This framework reflected the fact that what individuals eat may be correlated with what they ate at a previous point in time, and it helped to account for unobserved, individual-specific heterogeneity in attributes. This strategy also allowed respondents to remain in the study even if 1 measurement during the 3 examinations was missed.[20,21]

Because ego had the possibility of being described by 1 of 7 patterns, this estimation strategy resulted in a series of 28 binary models across 4 alter types. The contribution of alters' diet patterns to the variance explained was reported by using odds ratios that were adjusted for ego's gender, education, occupational prestige, age, BMI, servings of food per week, diet diversity, 2 measures of ego's network characteristics, and a measure of physical (geographic) distance between ego and alter.

A more restrictive set of models then substituted a lagged (instead of contemporaneous) term for alter diet so as to estimate the effect of alter's prior eating on ego's current eating pattern. These estimations further capitalized on the longitudinal structure of the data by helping to isolate the causal direction between the predictor and the outcome. We note that the included lag was only for 1 previous assessment of alter's eating; because we had data for only 3 survey waves in this analysis, the inclusion of a double lag would have been unwieldy. Data were analyzed by using Stata statistical software[22] and Pajek, a program for network analysis.[23]

RESULTS

Basic descriptive statistics of how the food patterns were distributed socioeconomically and demographically, as well as the distributions of the network covariates associated with each pattern, are reported in Table 1. Tests for trend across food patterns showed that differences in socioeconomic, demographic, and social network measures were all significantly different. Distributions by gender and education followed expectations based on previous research, with a greater proportion of women in the "healthier," "offsetting," "caffeine-avoidant," and "light" patterns. Those of higher socioeconomic status—that is, those with relatively more education and greater job prestige—were overrepresented in the "healthier," "offsetting," and "alcohol and snacks" patterns. Greater diet diversity was seen in "sweets" and "alcohol and snacks," whereas the greatest mean weekly consumption was seen in the "meat and soda," "sweets," and "offsetting" patterns. Social network covariates suggested that individuals who followed the "sweets" and "light" eating patterns were more socially connected than were their peers.

We also reported mean DGAI scores by food pattern to describe differences in the relative healthiness of each pattern. However, because we used the DGAI as an external metric to validate the dietary analysis procedure, we did not include it as a predictor in the longitudinal models.

Correlation Between Ego and Alter Food Patterns

The categorical association between the set of 7 ego and spouses' food patterns was statistically significant (χ^2=348.1, 36 *df*, pr<0.001) and moderate (Cramérs V=0.16), whereas the association between ego and friends' patterns was significant (χ^2=70.8, 36 *df*, pr<0.001) and slightly weaker (Cramér's V=0.13). Sibling associations with ego patterns were more attenuated; brothers' (χ^2=73.3, 36 *df*, pr<0.001, Cramér's V=.09) and sisters' (χ^2=78.7, 36 *df*, pr<0.001, Cramér's V=0.09) patterns were similarly associated with ego.

The strength of concordance between the food patterns of each type of ego/alter dyad are reported in Table 2. With few exceptions, food pattern correlations were most concordant among spouses and friends. Spouses tended to be most highly correlated on the "alcohol and snacks" pattern (r=0.25). Friends were most highly correlated on the "alcohol and snacks" and "healthier" patterns (r=0.10). Brothers were most highly correlated on the "meat and soda," "alcohol and snacks," and "healthier" patterns (r=0.07). Sisters tended to be most highly correlated on the "healthier" pattern (r=0.10).

TABLE 2—Correlations Between Ego and Alter Food Patterns: Framingham Heart Study Offspring Cohort, 1991–2001

Relationship Type	Meat and Soda	Sweets	Alcohol and Snacks	Light	Caffeine-Avoidant	Offsetting	Healthier
Spouses	0.19	0.11	0.25	0.09	0.15	0.17	0.13
Friends	0.00	0.05	0.10	0.01	0.06	0.06	0.10
Brothers	0.07	0.00	0.07	0.01	0.05	0.00	0.07
Sisters	0.06	0.00	0.05	0.00	0.05	0.02	0.10

Note. Alter refers to a contact while ego refers to a cohort member. Pairwise correlations reported across pooled examinations 5 to 7. Sample sizes were as follows: spouses, n = 6150; friends, n = 172; brothers, n = 4642; sisters, n = 4971.

Alter and Ego Food Patterns, and Measured Confounders

In light of the correlation in food consumption between egos and alters, we then sought to evaluate the predictive power of each alter's food pattern on the basis of what the ego ate by using a longitudinal random effects model. Ego eating was estimated by using 4 alter categories (spouse, friend, brother, and sister) and 7 food patterns (meat and soda, sweets, alcohol and snacks, light, caffeine-avoidant, offsetting, and healthier), resulting in 28 discrete models. For convenience of reporting results, we grouped all peer types (spouses, friends, brothers, and sisters) in Table 3. The contributions of multiple levels of a categorical predictor, such as food choice, are necessarily interpreted in relation to a reference category. Here, an intuitive reference category was the concordant food pattern of ego and alter. For reasons of space, we discuss only selected models here to orient readers to model interpretation. Full models that report unadjusted odds ratios, contributions of socioeconomic and demographic confounders, and diet and social network control variables are included in

TABLE 3—Relationship of Alter and Ego Food Patterns in Adjusted Longitudinal Logistic Regression Models: Framingham Heart Study Offspring Cohort, 1991–2001

Alter Food Patterns	Ego Meat and Soda, AOR (95% CI)	Ego Sweets, AOR (95% CI)	Ego Alcohol and Snacks, AOR (95% CI)	Ego Light, AOR (95% CI)	Ego Caffeine-Avoidant, AOR (95% CI)	Ego Offsetting, AOR (95% CI)	Ego Healthier, AOR (95% CI)
Spouse's eating (n = 1027)							
Meat and soda (base)	–	1.203 (0.538, 2.688)	0.0812*** (0.030, 0.218)	1.070 (0.424, 2.695)	0.260*** (0.125, 0.544)	0.252*** (0.140, 0.453)	0.281*** (0.153, 0.518)
Sweets	0.349*** (0.158, 0.772)	–	0.0958*** (0.032, 0.290)	1.416 (0.517, 3.880)	0.352*** (0.160, 0.775)	0.373*** (0.190, 0.729)	0.464** (0.237, 0.908)
Alcohol and snacks	0.181*** (0.081, 0.403)	0.544 (0.222, 1.332)	–	0.713 (0.276, 1.841)	0.276*** (0.127, 0.598)	0.203*** (0.104, 0.397)	0.345*** (0.188, 0.635)
Light	0.239*** (0.106, 0.538)	1.182 (0.488, 2.861)	0.0851*** (0.029, 0.247)	–	0.457** (0.212, 0.984)	0.415*** (0.216, 0.796)	0.390*** (0.206, 0.740)
Caffeine-avoidant	0.128*** (0.057, 0.287)	1.069 (0.471, 2.427)	0.0994*** (0.037, 0.266)	1.575 (0.619, 4.011)	–	0.328*** (0.178, 0.605)	0.451*** (0.246, 0.825)
Offsetting	0.139*** (0.067, 0.289)	0.618 (0.274, 1.394)	0.0566*** (0.021, 0.150)	1.725 (0.721, 4.125)	0.365*** (0.188, 0.712)	–	0.421*** (0.246, 0.719)
Healthier	0.169*** (0.085, 0.337)	0.821 (0.379, 1.777)	0.0744*** (0.031, 0.178)	1.458 (0.647, 3.284)	0.326*** (0.174, 0.612)	0.361*** (0.219, 0.597)	–
Friend's eating (n = 324)							
Meat and soda (base)	–	0.591 (0.139, 2.512)	0.186** (0.036, 0.959)	2.038 (0.404, 10.28)	0.559 (0.160, 1.957)	0.510 (0.148, 1.757)	0.447 (0.161, 1.240)
Sweets	2.037 (0.375, 11.05)	–	0.0571*** (0.007, 0.454)	0.548 (0.066, 4.586)	0.556 (0.148, 2.090)	0.405 (0.010, 1.640)	0.851 (0.301, 2.407)
Alcohol and snacks	0.478 (0.064, 3.597)	0.114** (0.016, 0.842)	–	0.802 (0.157, 4.114)	0.174* (0.030, 1.017)	0.646 (0.179, 2.334)	0.753 (0.250, 2.268)
Light	0.966 (0.147, 6.355)	0.628 (0.126, 3.139)	0.255* (0.050, 1.296)	–	0.627 (0.160, 2.463)	0.755 (0.216, 2.637)	0.378* (0.123, 1.165)
Caffeine-avoidant	0.885 (0.142, 5.536)	0.773 (0.185, 3.222)	0.120** (0.021, 0.701)	0.440 (0.079, 2.454)	–	0.447 (0.124, 1.614)	0.938 (0.349, 2.526)
Offsetting	0.387 (0.064, 2.362)	0.751 (0.183, 3.084)	0.253* (0.057, 1.127)	0.197* (0.033, 1.184)	0.840 (0.260, 2.712)	–	0.697 (0.274, 1.774)
Healthier	0.418 (0.074, 2.363)	0.314 (0.073, 1.340)	0.167** (0.033, 0.838)	0.479 (0.109, 2.100)	0.274** (0.085, 0.889)	1.796 (0.655, 4.923)	–
Brother's eating (n = 752)							
Meat and soda (base)	–	1.604 (0.667, 3.861)	0.305** (0.118, 0.787)	2.758 (0.822, 9.247)	0.384** (0.171, 0.859)	1.254 (0.601, 2.616)	0.454** (0.243, 0.847)
Sweets	0.655 (0.312, 1.374)	–	0.397 (0.125, 1.261)	1.740 (0.435, 6.951)	0.969 (0.405, 2.318)	1.010 (0.426, 2.394)	0.663 (0.318, 1.384)
Alcohol and snacks	0.490** (0.254, 0.946)	0.905 (0.342, 2.395)	–	1.107 (0.303, 4.044)	0.515 (0.225, 1.177)	1.277 (0.599, 2.726)	0.712 (0.378, 1.341)
Light	1.301 (0.610, 2.774)	0.695 (0.221, 2.185)	0.554 (0.172, 1.785)	–	0.531 (0.199, 1.415)	0.495 (0.165, 1.483)	0.938 (0.426, 2.065)
Caffeine-avoidant	0.356** (0.158, 0.804)	2.086 (0.776, 5.608)	0.327* (0.104, 1.022)	2.069 (0.477, 8.974)	–	0.985 (0.413, 2.351)	0.671 (0.314, 1.432)
Offsetting	0.829 (0.419, 1.640)	1.107 (0.412, 2.974)	0.708 (0.268, 1.868)	2.106 (0.577, 7.684)	0.300*** (0.122, 0.734)	–	0.712 (0.372, 1.363)
Healthier	0.629 (0.330, 1.200)	1.246 (0.495, 3.137)	0.606 (0.250, 1.469)	1.545 (0.445, 5.370)	0.401** (0.173, 0.930)	0.881 (0.415, 1.870)	–
Sister's eating (n = 785)							
Meat and soda (base)	–	0.674 (0.237, 1.916)	0.535 (0.162, 1.763)	0.485 (0.137, 1.710)	0.569 (0.211, 1.530)	1.273 (0.567, 2.858)	0.449** (0.209, 0.964)
Sweets	1.444 (0.628, 3.320)	–	0.397 (0.113, 1.397)	1.263 (0.352, 4.528)	0.755 (0.273, 2.091)	0.542 (0.208, 1.413)	0.511* (0.233, 1.120)
Alcohol and snacks	0.521 (0.212, 1.277)	0.722 (0.246, 2.119)	–	0.824 (0.237, 2.864)	0.416 (0.146, 1.186)	1.790 (0.790, 4.056)	0.638 (0.305, 1.333)
Light	0.427* (0.180, 1.013)	0.985 (0.349, 2.780)	0.585 (0.179, 1.909)	–	1.126 (0.441, 2.871)	0.832 (0.356, 1.942)	0.924 (0.462, 1.849)
Caffeine-avoidant	0.829 (0.370, 1.858)	1.454 (0.558, 3.789)	0.208** (0.056, 0.777)	0.626 (0.195, 2.016)	–	0.875 (0.385, 1.989)	0.677 (0.343, 1.336)
Offsetting	0.805 (0.370, 1.749)	0.545 (0.200, 1.484)	0.547 (0.184, 1.628)	1.013 (0.296, 3.464)	0.741 (0.309, 1.778)	–	0.809 (0.431, 1.515)
Healthier	0.504* (0.252, 1.010)	0.947 (0.403, 2.225)	1.014 (0.397, 2.592)	0.582 (0.210, 1.609)	0.600 (0.279, 1.290)	0.895 (0.461, 1.737)	–

Note. AOR = adjusted odds ratio; CI = confidence interval. Alter refers to a contact while ego refers to a cohort member. Although the models are arrayed together for ease of interpretation, each ego food pattern was treated as a discrete binary outcome; thus, this table arrays 28 different models.
***P < .01; **P < .05; *P < .1.

Tables D-G Appendix available as a supplement to the online version of this article at http://www.ajph.org).

After adjustment for the contributions of sociodemographic confounders, spouses were still likely to be concordant on 5 of 7 food patterns: "healthier," "offsetting," "caffeine-avoidant," "alcohol and snacks," and "meat and soda" (Table 3). Compared with spouses who both ate "meat and soda," alters were significantly less likely to follow any other food pattern (all other categories of spouse's food pattern had adjusted odds ratios <1.0). Here, an odds ratio of 0.349 among "sweets" eaters meant that relative to spouses who both ate "meat and soda," an ego was 2.9 times less likely (1/0.349) to eat "meat and soda" if their spouse ate "sweets." If a spouse ate "meat and soda," their partner was 5.9 times less likely to eat "healthier."

In terms of other alter types, friends were likely to be concordant on "alcohol and snacks," "caffeine-avoidant," and "sweets" (Table 3). Siblings were similarly likely to be concordant on several food patterns. Brothers were significantly likely to be concordant on "meat and soda," "alcohol and snacks," "caffeine-avoidant," and "healthier" patterns (Table 4). Sisters were likely to be concordant on "alcohol and snacks" and "healthier" food patterns (Table 4).

Lagged Alter and Current Ego Food Patterns

Whereas the foregoing analyses demonstrated the strength of eating relationships and highlighted a social dimension to eating, a more restrictive set of models predicted current ego eating on the basis of what alters ate at the previous examination period. This lagged

TABLE 4—Relationship Between Lagged Alter and Current Ego Food Patterns (adjusted longitudinal logistic regression models with lagged alter eating specification): Framingham Heart Study Offspring Cohort, 1991–2001

Alter Food Patterns	Ego Meat and Soda, AOR (95% CI)	Ego Sweets, AOR (95% CI)	Ego Alcohol and Snacks, AOR (95% CI)	Ego Light, AOR (95% CI)	Ego Caffeine-Avoidant, AOR (95% CI)	Ego Offsetting, AOR (95% CI)	Ego Healthier, AOR (95% CI)
Spouse's eating,							
T-1 (n = 806)							
Meat and Soda (base)	–	1.064 (0.398, 2.843)	0.100*** (0.029, 0.345)	1.481 (0.437, 5.023)	0.258** (0.083, 0.797)	0.346*** (0.160, 0.748)	0.407** (0.188, 0.881)
Sweets	0.154*** (0.050, 0.472)	–	0.0963*** (0.024, 0.390)	4.498** (1.133, 17.87)	0.601 (0.195, 1.857)	0.430* (0.181, 1.025)	0.826 (0.366, 1.864)
Alcohol and snacks	0.268*** (0.099, 0.727)	0.605 (0.207, 1.768)	–	0.788 (0.205, 3.028)	0.312* (0.096, 1.015)	0.213*** (0.085, 0.534)	0.687 (0.318, 1.485)
Light	0.259** (0.088, 0.759)	0.886 (0.291, 2.699)	0.114*** (0.029, 0.449)	–	0.929 (0.293, 2.948)	0.596 (0.251, 1.416)	0.563 (0.245, 1.295)
Caffeine-avoidant	0.153*** (0.052, 0.457)	1.070 (0.387, 2.959)	0.0778*** (0.020, 0.301)	2.492 (0.712, 8.720)	–	0.182*** (0.072, 0.456)	0.874 (0.411, 1.858)
Offsetting	0.366** (0.152, 0.882)	0.356* (0.124, 1.020)	0.0653*** (0.018, 0.232)	2.177 (0.627, 7.562)	0.392* (0.139, 1.109)	–	0.556* (0.277, 1.118)
Healthier	0.272*** (0.111, 0.667)	0.508 (0.189, 1.367)	0.199*** (0.068, 0.584)	1.444 (0.440, 4.735)	0.228*** (0.079, 0.659)	0.523* (0.261, 1.050)	–
Friend's eating,							
T-1 (n = 230)							
Meat and soda (base)	–	0.190 (0.007, 5.313)	0.295* (0.076, 1.145)	1.538 (0.265, 8.933)	1.349 (0.140, 13.01)	0.259* (0.057, 1.166)	0.868 (0.243, 3.103)
Sweets	0.0143* (0.000, 1.958)	–	0.146** (0.027, 0.786)	2.368 (0.390, 14.39)	1.780 (0.208, 15.28)	0.300 (0.062, 1.467)	1.550 (0.403, 5.962)
Alcohol and snacks	0.266 (0.009, 7.495)	0.136 (0.003, 6.264)	–	0.764 (0.093, 6.306)	1.059 (0.086, 13.09)	0.293 (0.054, 1.602)	0.731 (0.153, 3.491)
Light	0.120 (0.004, 3.603)	0.468 (0.018, 12.53)	0.368 (0.080, 1.688)	–	1.348 (0.146, 12.46)	0.251 (0.044, 1.446)	1.633 (0.377, 7.086)
Caffeine-avoidant	0.151 (0.006, 3.612)	1.452 (0.082, 25.64)	0.112** (0.019, 0.683)	1.037 (0.190, 5.644)	–	0.149** (0.024, 0.937)	2.451 (0.653, 9.205)
Offsetting	0.125 (0.006, 2.569)	0.448 (0.029, 7.090)	0.126** (0.025, 0.634)	0.612 (0.100, 3.763)	1.403 (0.201, 9.819)	–	1.478 (0.457, 4.780)
Healthier	0.165 (0.010, 2.721)	0.413 (0.026, 6.580)	0.166** (0.038, 0.733)	1.701 (0.359, 8.050)	0.918 (0.149, 5.639)	0.713 (0.208, 2.441)	–
Brother's eating,							
T-1 (n = 606)							
Meat and soda (base)	–	0.505 (0.190, 1.343)	1.339 (0.472, 3.794)	1.007 (0.260, 3.905)	0.693 (0.228, 2.103)	0.520 (0.144, 1.870)	0.394** (0.193, 0.802)
Sweets	1.055 (0.314, 3.543)	–	0.447 (0.112, 1.787)	0.354 (0.068, 1.856)	1.165 (0.333, 4.073)	0.412 (0.093, 1.831)	0.340** (0.141, 0.818)
Alcohol and snacks	0.516 (0.169, 1.577)	0.284** (0.089, 0.901)	–	1.157 (0.262, 5.108)	0.836 (0.256, 2.727)	1.050 (0.299, 3.681)	0.575 (0.272, 1.215)
Light	0.200** (0.044, 0.916)	0.927 (0.280, 3.071)	0.583 (0.138, 2.461)	–	1.996 (0.538, 7.410)	0.834 (0.158, 4.408)	0.345** (0.126, 0.945)
Caffeine-avoidant	1.079 (0.315, 3.693)	0.291* (0.084, 1.008)	0.491 (0.125, 1.927)	0.411 (0.072, 2.351)	–	1.480 (0.377, 5.811)	0.606 (0.261, 1.409)
Offsetting	1.269 (0.424, 3.797)	0.222** (0.065, 0.759)	1.346 (0.435, 4.166)	0.429 (0.082, 2.236)	0.304* (0.079, 1.170)	–	0.819 (0.392, 1.715)
Healthier	0.369* (0.116, 1.170)	0.389* (0.132, 1.147)	1.218 (0.421, 3.522)	0.299 (0.063, 1.412)	0.855 (0.271, 2.699)	0.602 (0.174, 2.075)	–
Sister's eating,							
T-1 (n = 613)							
Meat and soda (base)	–	0.180** (0.039, 0.828)	0.999 (0.267, 3.738)	1.942 (0.379, 9.964)	0.120** (0.021, 0.695)	1.192 (0.436, 3.257)	0.611 (0.281, 1.327)
Sweets	1.472 (0.500, 4.331)	–	0.121** (0.024, 0.622)	7.945** (1.367, 46.20)	0.0533** (0.006, 0.514)	0.477 (0.139, 1.642)	0.717 (0.304, 1.689)
Alcohol and snacks	0.627 (0.194, 2.028)	0.287* (0.066, 1.253)	–	1.983 (0.367, 10.71)	0.0899** (0.014, 0.594)	0.828 (0.278, 2.464)	1.036 (0.482, 2.227)
Light	0.770 (0.248, 2.393)	0.691 (0.182, 2.621)	0.481 (0.115, 2.010)	–	0.248 (0.045, 1.377)	0.769 (0.249, 2.380)	0.977 (0.435, 2.194)
Caffeine-avoidant	0.683 (0.227, 2.054)	0.487 (0.132, 1.801)	0.126*** (0.026, 0.606)	2.283 (0.457, 11.41)	–	1.075 (0.379, 3.043)	0.765 (0.355, 1.649)
Offsetting	0.516 (0.163, 1.637)	0.427 (0.112, 1.634)	0.236* (0.054, 1.040)	0.402 (0.053, 3.028)	0.251* (0.050, 1.273)	–	1.551 (0.734, 3.279)
Healthier	0.570 (0.227, 1.433)	0.539 (0.179, 1.624)	0.157*** (0.044, 0.557)	2.325 (0.556, 9.713)	0.385 (0.111, 1.332)	1.082 (0.450, 2.600)	–

Note. AOR = adjusted odds ratio; CI = confidence interval. T-1 refers to prior panel measurement. Although the models are arrayed together for ease of interpretation, each ego food pattern was treated as a discrete binary outcome; thus, this table arrays 28 different models.
***P < .01; **P < .05; *P < .1.

specification is a way to test for evidence of social influence in eating. The necessity of excluding a panel as a categorical referent in the longitudinal framework constrained the estimation of ego's food pattern (at examination 7) based on alter eating (at examination 6); hence, the sample size was slightly reduced. Unadjusted models are included in Tables H-K Appendix available as a supplement to the online version of this article at http://www.ajph.org).

After we accounted for the contributions of sociodemographic confounders, an individual was likely to be concordant (at examination 7) with their spouse's previous food pattern (at examination 6) on 6 of 7 food patterns (the exception was "sweets") (Table 4). Individuals were more likely to be concordant with their friend's previous "alcohol and snacks" and "offsetting" patterns (Table 4). Among siblings, having a brother who formerly ate "meat and soda," "sweets," "caffeine-avoidant," or "healthier" patterns predicted that the ego would eat that pattern in the future (Table 4). Having a sister who ate "sweets," "alcohol and snacks," "light," or "caffeine-avoidant" patterns predicted future sibling concordance (Table 4).

DISCUSSION

Our basic findings regarding diet patterns are consistent with previous research on the Framingham Offspring cohort that found a delimited number of patterns to be useful to describe the population.[24,25] This set of patterns also comports with other populations that have enumerated healthier, sweets, and alcohol diet patterns.[18,26–30] However, our main objective here was to examine how ego eating was related to alter eating and to account for how individuals changed their diet over time. These are relatively newer questions. Our study is thus unusual in that we combined diet pattern analysis with dyadic social network data to trace relationships between individuals' eating behaviors over a relatively long time period in a natural setting.

There were strong concordances in contemporaneous spouse food choice; for 5 of the 7 food patterns enumerated, a spouse's concordant food pattern predicted ego eating (the exceptions were "sweets" and "light" eaters). Among friends, having a friend who followed the "alcohol and snacks," "sweets," or "caffeine-avoidant" patterns modestly predicted that the ego would eat the same as well. Brothers tended to be concordant on "meat and soda," "alcohol and snacks," "caffeine-avoidant," and "healthier" patterns; sisters exhibited concordance on "alcohol and snacks" and "healthier" patterns. Across all types of relationships, having an alter who was a light eater was the least predictive of the connected ego's food choice, whereas "alcohol and snacks" predicted eating concordance best, regardless of relationship.

Moreover, across all alter types, these results were highly robust to the inclusion of a lagged (instead of contemporaneous) term for alter's food choice. The finding that what a socially connected peer ate at a previous point in time predicted current ego concordance provides evidence of a social influence process. For instance, among spouses, the knowledge that a spouse either currently eats or previously ate "meat and soda," "alcohol and snacks," "caffeine-avoidant," "offsetting," or "healthier" predicted that the other spouse would eat concordantly in the future. Among friends, "alcohol and snacks" was similarly robust to contemporaneous or lagged model specification. Among siblings, "meat and soda" and "healthier" patterns were robust among brothers over time, whereas "alcohol and snacks" was robust in the case of sisters.

These findings extend existing research on health concordance, commensality, and social influence to incorporate a broader variety of naturally occurring network ties and food choices, both followed for a long period. Although previous work was interested in examining social influence related to BMI,[4] a focus on social influence associated with food choice suggests an important mediating pathway. The present findings that food choices are statistically predictive of what connected alters eat harmonizes with the explanation that food choice may be a mediating pathway for interpersonal effects with respect to obesity.[4,12] The rather consistent emergence of "alcohol and snacks" as a concordant pattern across relationship types harmonizes with the intuition that this form of consumption is also intrinsically more social in nature. Items in this food pattern are easy to share and often require less of a time commitment relative to meals; in addition, in American society, alcohol is culturally associated with sociability.

Our work has important limitations. By design, we did not simultaneously examine all of the reported relationships that an ego has with those around him or her; instead, we examined only close social contacts on a dyadic basis. An additional limitation of the present approach was that we were not able to ascertain whether peers ate together, nor whether food was a significant topic of conversation.

Our findings give empirical support to the idea that considering the structure of relationships in models of food choice is valuable. This value can be seen at the level of the food system by more thoroughly specifying one's social environment[31] or at the level of individuals' choices[32] by more clearly specifying personal factors. The knowledge that our eating patterns are similar to the eating patterns of those with whom we are socially connected contributes to the perspective—increasingly more supported in the public health field—that when people are connected, their health is connected. To the extent that people's eating choices are influenced by the eating choices of those to whom they are connected, it may not simply be that "you are what you eat." It may be that "you are what people in your social network eat" as well. ■

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Contributors

M. A. Pachucki developed and implemented the study and conducted the data analyses. P. F. Jacques contributed epidemiological guidance and critical revisions of the article. N. A. Christakis contributed to research design and critical revisions of the article.

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Human Participant Protection

This study was approved by the institutional review boards of the Harvard University Faculty of Arts and Sciences and Harvard Medical School. Survey respondents gave informed consent before participating.

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