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# Identification and Description of Potentially Influential Social Network Members: Application of the Strategic Player Approach

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## Abstract

**Background—**Diffusion of innovations theory posits that ideas and behaviors can be spread through social network ties. In intervention work, intervening upon certain network members may lead to intervention effects “diffusing” into the network to affect the behavior of network members who did not receive the intervention. The strategic players (SP) method, an extension of Borgatti’s Key Players approach, is used to balance the (sometimes) opposing goals of spreading the intervention to as many members of the target group as possible, while preventing the spread of the intervention to others.

**Objectives—**We sought to test whether members of the SP set have network position and non-network differences (such as demographic, attitudinal, or behavioral differences) compared to the remaining members of the target group (non-SPs).

**Methods—**A first-year class at a private residential university (N = 1342) completed network and non-network measures. Analyses were restricted only to heavy drinkers, leading to a final analytic sample of 529.

**Results—**SPs and non-SPs differed on multiple network variables, but did not differ on most demographic, attitudinal, and behavior variables.

**Conclusions—**As designed, the SP program identified participants who were distinguished by their network position. The fact that they did not also differ on other characteristics shows the SPs are not significantly different than heavy drinkers who were not selected.

### Keywords

Network Intervention; Heavy Drinking; College Alcohol Use; Network Diffusion; Social Network

## Introduction

It has long been established that influence from peers can impact behavior (Kelman, 1958), and there has been a recent increase in the use of social network methodology for intervention development and implementation across a host of health behaviors, including family planning, weight loss, diabetes care, smoking cessation, and HIV risk reduction (Latkin & Knowlton, 2015). When constructing a network intervention, there are many important considerations to address. The nature of the social network, the behavior of interest, and the type of intervention all affect the type of network intervention that may be implemented according to the current theoretical frameworks (T. W. Valente, 2012).

Diffusion of innovations theory has provided a theoretical foundation for designing and implementing network interventions. Diffusion of innovations posits that ideas and behaviors spread within a network based on interactions between members of the network (Latkin & Knowlton, 2015; T. W. Valente, 2012). Network interventions attempt to harness this natural process and maximize its efficacy in spreading ideas and behaviors. In health behavior change research, the goal of a network intervention is to promote a healthy behavior or dissuade an unhealthy behavior, using the network members to provide and/or transmit the intervention. T. W. Valente (2012) has described different methods for intervening on a network, the most common is an individual-level intervention, in which individuals within the network are identified, based on a list of a priori credentials, to be intervention agents. These individuals are targets of the intervention itself, but by nature of network theory, are presumed to expose others to the intervention through their social relationships (T. W. Valente, 2012). A common network intervention of this type uses opinion leaders to diffuse behavior change; the opinion leaders are identified by asking network members to nominate other network members they find to be influential (T. W. Valente, 2012). One concern with this method is that nominations by other network members may not identify leaders who occupy network positions optimal for behavioral diffusion (Zhang, Shoham, Tesdahl, & Gesell, 2015).

As an alternative to this opinion leader methodology, mathematical algorithms have been utilized to determine the most influential members of the network (Long, Cunningham, & Braithwaite, 2012; Schoenberg et al., 2016; Thomas W Valente, Palinkas, Czaja, Chu, & Brown, 2015; Young et al., 2017). One of the most notable methodologies of this kind was developed by Borgatti (2006), who refers to his technique as the “Key Player” (KP) approach. The KP algorithm identifies a set of network members who most optimally span the network (Borgatti, 2006). In the KP approach, it is assumed that all network members should be considered as potential targets for the intervention, though this may not be the

case for some interventions. For instance, in some network interventions such as those that designate a subset of network members as controls, it would be important to avoid choosing network members who are controls or proximate to controls. The KP approach would not be optimal for this purpose since it would be likely to include the controls in the derived KP set.

The strategic players (SP) method is an extension of Borgatti's Key Players that addresses some of its limitations. The SP algorithm was developed to allow for the investigation of the effect of an intervention that was administered to a minimum number of individuals within a social network, with the expectation that the intervention would also affect others in the network who did not receive the intervention. In this network, three subgroups are defined: individuals who were the intended *targets* of the intervention because they were members of the intervention group who engaged in the focal behavior (in our case heavy episodic drinking), individuals to *avoid* receiving the intervention (because they were heavy drinking members in the control group), and individuals who were neither targets nor avoids (non-heavy drinkers); we consider these individuals' *neutral*. The SP algorithm, then, was designed to balance the goals of spreading the intervention to as many members of the target group as possible, while simultaneously preventing the spread of the intervention to the members of the avoid group.

As an illustration, consider a weight-loss intervention being conducted with a network of individuals. The network is composed of individuals who would benefit from losing weight (the target group), individuals who could be harmed by being exposed to a weight-loss intervention such as individuals with an eating disorder (the avoid group), and individuals who would neither be harmed by nor would they benefit from the intervention (the neutral group). In this illustration, the SP algorithm would seek to identify a subset of individuals in the target group who are more proximate in the network to other target group members, while being at a greater distance in the network from members of the avoid group.

Another situation in which the SP method could be used is when there are individuals in the network who have been designated as controls, with the goal being that these controls are neither exposed to the intervention directly nor indirectly through their social ties in the network. In the current study in which we conducted an intervention to reduce hazardous alcohol use in a large network, the heavy drinkers in the network were identified, with roughly half chosen to be control group members (the avoid group), and the other half the target group for the intervention. Individuals in the network who were not heavy drinkers were considered to be members of the neutral group. In this situation, we would use the SP method to identify members of the target group (heavy drinkers who are not controls) who are close to other target group members, while being further away in the network from controls (the avoid group).

In social network terminology, the goal of the SP approach is to identify an optimal subset (called the SP set) of the target group who will receive the intervention, whereby the geodesic distance (the shortest path) between members of the target group and the SP set is minimized, thus increasing the likelihood of the intervention spreading to those who are not in the SP set but who engage in the focal behavior. The SP approach also attempts to

maximize the geodesic distance between members of the SP set and the avoid group, thus decreasing the likelihood of the intervention spreading to this group (i.e., the control group).

In the SP method the researcher must first define the importance of the two goals of 1) minimizing the geodesic distance from the SP set to the target group and 2) maximizing the geodesic distance from the SP set to the members of the avoid group. This is done by establishing the prioritization parameter (theta). When theta is set to zero, the SP algorithm will prioritize minimizing the distance between the SP set and the remaining members of the target group. When theta is set to one, the SP algorithm will prioritize maximizing the geodesic distance between the SP set and members of the avoid group. Values of theta between 0 and 1 reflect the relative importance of minimizing distance to the remaining members of the target group and maximizing distance to the avoid group (Ott, Light, Clark, & Barnett, 2018).

In order to implement the SP method, the researcher must provide the social network structure (i.e., who is connected with whom), identify the members of the target, avoid, and neutral groups, determine the number of individuals to intervene upon (i.e., the size of the SP set), and lastly specify the theta parameter which specifies the importance of minimizing the distance between SP members and the remaining target group members as opposed to maximizing the distance between the SP members and the avoid group members. This information can be passed into the strategicplayers R package (Ott, 2016), which will then output the list of SP members.

It is important to emphasize that the SP approach identifies the optimal set of network members who are considered targets for the intervention and who have the optimal reach to other targeted network members. It will not necessarily identify individuals who would be selected by other network members as influential, and ideally the SP set will not differ from the other members of the target group except in their (closer) proximity to other members of the target group and (greater) proximity to members of the avoid group. However, it is possible that the SP algorithm will result in unintended differences between members of the SP set and the remaining members of the target group.

The objective of this paper is to investigate the SP method for identifying social network intervention recipients, and specifically to determine whether the SPs selected differ from other non-SP members of the target group. First, we introduce our network intervention study in which the SP method was utilized. Next we compare the members of the target groups who were chosen as SPs to the target group members who were not chosen as SPs. In these comparisons, significant group differences on non-network variables (demographic and alcohol use variables) would indicate that the SP method results in an SP set that does not differ only on network position. We expected that the SPs would differ significantly from non-SPs only on network variables but would not differ from non-SPs on demographic, drinking, or behavioral variables.

# Methods

## Design

The primary goal of the study in which these data were collected was to investigate whether administering a brief alcohol intervention to a minority of network members would significantly reduce drinking and alcohol-related consequences among network members who did not receive the intervention. The entire first-year class at a private residential university ($N$ = 1660) was recruited to participate. Students who enrolled in the study and completed the assessment in the fall semester ($N$ = 1342; 55.3% female; 47.7 Non-Hispanic white).

We sought to identify individuals who would receive the intervention using the Strategic Player (SP) method. The target group in this investigation was heavy drinkers, defined as reporting two or more heavy drinking episodes (the consumption of 4+ drinks for females and 5+ for males) in the past 30 days. The avoid group was heavy drinkers in the other part of the college campus. The neutral group was comprised of network members who were not heavy drinkers.

One of the key assumptions of this study is that the individuals chosen as SPs were similar to the target group members (the other heavy drinkers not chosen as SPs) in all ways except their position in the network (SPs are chosen such that they might be influential to other heavy drinkers, we expect that SPs are more highly connected and central within the network). The goal of this paper is to investigate this assumption. As such, our analyses specifically compared heavy drinkers who were and were not selected as SPs; we therefore restricted the analytic sample to only heavy drinkers (n = 529).

## Procedures

The SP method (Ott, 2016; Ott et al., 2018) was run on the social network. The theta parameter was set at .6 (setting a moderate prioritization of close network proximity in terms of geodesic distance to members of the target group over the distant network proximity to members of the avoid group), which we found allowed for a high proportion of target group members to be close to the SP group while having a low proportion of the avoid group members in close proximity to the SP group. Our plan was to include approximately 25% of the target group in the intervention, and since we expected approximately 10% non-completion of the intervention, increased the number of SPs chosen to be 27% of the target group, which resulted in 145 members as SPs.

## Measures

**Demographic information.—**Participants reported their race, ethnicity, and birth sex.

**Network Measures.—**Participants were asked to name up to 10 individuals in their first-year class who had been important to them (adapted from the Important People Instrument, Longabaugh & Zywiak, 1998). A dropdown list of all students in the first-year class was provided. If they could not find a name in the dropdown list, they were asked to select “I can’t find this person in the list”. Using the network information gathered from the survey,

indegree (a measure of popularity) was calculated as the number of nominations a person received, and outdegree (a measure of expansiveness) was calculated as the number of nominations that a respondent made. Mutuality (a measure of relationship agreement) was calculated as the proportion of ties (either to or from an individual) that were reciprocated. Eigenvector centrality (global popularity) and betweenness centrality (role as a bridge between disparate groups in the network) were calculated using the SNA package in R (Butts, 2010). Ego density (connectivity among ties) was calculated as the number of ties that exist between an individual's friends divided by the maximum number of ties that could exist, where higher ego density scores reflect that the ego is friends with individuals who tend to be friends with each other, and low ego density scores reflect that the ego is friends with people who tend not to be friends with each other.

**Alcohol use.—**We employed four alcohol use items, all which were measured consumption over the past 30 days: drinking frequency, drinking quantity, heavy drinking, and maximum number of drinks. Prior to being administered questions about recent alcohol use, participants were presented with a chart that defined a standard drink as 12 oz. of beer, 5 oz. of wine, or 1 oz. shot of liquor. *Drinking frequency* was measured as the number of days participants had consumed alcohol in the past 30 days. *Drinking quantity* was reflected by drinks per week, calculated using an item asking how many drinks participants consumed on a typical drinking day and multiplying that value by drinking frequency. *Heavy drinking* was defined as the number of days participants had consumed 4/5+ (female/males) drinks in one drinking occasion. *Maximum number of drinks* was defined as the highest number of drinks participants had consumed on a drinking day.

**Alcohol-related consequences.—**Alcohol-related consequences were measured using the Brief Young Adult Consequences Questionnaire (BYAACQ) (Kahler, Strong, & Read, 2005), a well-validated, 24-item measure. Participants were asked to respond to whether or not they had experienced each problem as a result of drinking in the past 30 days, for example, "I have felt very sick to my stomach or thrown up after drinking" and "I have woken up in an unexpected place after heavy drinking." Responses were dichotomous (*yes/no*) and a summary score was computed (Cronbach alpha =0.82).

The following constructs were selected as individual level variables of interest because all have shown to be related to alcohol use and or behavior change, and specifically behavior change associated with alcohol intervention outcomes in college students (Bock et al., 2016; DiBello, Miller, Neighbors, Reid, & Carey, 2017; DiGuiseppi et al., 2017; Grossbard et al., 2016; White, Anderson, Ray, & Mun, 2016).

**Readiness to Change Questionnaire (RTCQ).—**The 4-item contemplation subscale from the RTCQ measures the extent to which respondents are contemplating changing their drinking (e.g., "I am at the stage where I could think about drinking less") Response options ranged from −2 (*strongly disagree*) to 2 (*strongly agree*), with the 0 value representing "unsure". A summary score was computed for this measure (Heather, Gold, & Rollnick, 1991).

**Alcohol self-efficacy.—**Participants were asked to indicate their level of confidence in their ability to cut down on their drinking if they wanted to using a single item. The range of responses was from 0% (*not at all confident*) to 100% (*totally confident*) (Breslin, Sobell, Sobell, & Agrawal, 2000).

**Drinking Motives Questionnaire Revised Short Form (DMQ-R SF).—**The DMQ was used to determine participant motives for consuming alcohol across four subscales: social, coping, enhancement, and conformity. Using the short form, participants responded to 12 items after the stem "thinking of all the times you drink, how often would you say that you drink for each of the following reasons". Response options range from 1 (*almost never/never*) to 5 (*almost always/always*). A summary score was calculated for the full scale[1] (Cooper, 1994). Cronbach's alpha values for the overall scale was 0.86.

**Resistance to Peer Influence (RPI).—**Resistance to peer influence was measured using 10 items, each item describing two different types of people, separated by the conjunction "BUT" (e.g., "Some people go along with their friends just to keep their friends happy BUT Other people refuse to go along with what their friends want to do, even though they know it will make their friends unhappy"). Participants were asked to choose which of the descriptions best describes them. Participants were then asked to select "really true for me" or "sort of true for me" for the description that described them (Steinberg & Monahan, 2007). (Cronbach alpha for sample=0.73).

**Perceptions of own supportiveness of others' drinking safety.—**Items were developed to measure participants' supportiveness of other students' decisions not to drink or to be safer when they drink over the past 30 days. The item of interest here asked "to what extent have you been supportive of others' decisions not to drink?". Response options ranged from 0 (*not at all supportive*) to 5 (*extremely supportive*).

## Data Analysis

To identify differences between the SP set and non-SP target group members we considered data collected at the baseline of the study (prior to any intervention). Although the purpose of the parent investigation was to separate the network into two groups (geographically by dormitory) and administer an intervention to the Brief Medical Interview (BMI) group, since the data used in these analyses were collected prior to intervention administration we combined the two SP sets (i.e., the BMI and control SPs) and compared them to the two non-SP sets on demographics, drinking variables, and network characteristics using independent samples t-tests and chi square tests for association. By combining all SP members (both BMI and Control) to form one large SP group, we are able to have a larger samples size to aid in comparisons between SPs and non-SP target group members. All analyses were conducted in SPSS 24.

[1]The four subscales prescribed for this measure were also examined. None reflected significant differences between SPs and heavy drinking non-SPs.

## Results

Demographic and drinking variables are reported in Table 1. None of the demographic variables showed statistically significant differences between groups. Drinking frequency was the only alcohol use measure that showed significant differences between groups, with non-SPs reporting greater drinking frequency than SPs.

There were three significant differences based on SP status out of the six network variables compared. On these three constructs (outdegree, mutuality, and betweenness centrality), non-SPs had higher means (*ps*<.001). For instance, for betweenness centrality, SPs had a negative mean value, while the non-SPs had a positive value. Indegree, eigenvector centrality, and ego density did not differ between the two groups (Table 1).

## Discussion

Strategic Players is a new method for identifying potentially influential members in social network behavioral interventions. Strategic players were chosen from the target group set based on their position in the social network relative to how close they were to other target group members, and how far they were from the avoid group members in terms of geodesic distance in the network. Although demographic or other attributes did not contribute to selection into the SP set, it is important to determine if there are associations between SP set status and those attributes. Using this recent study as an example, we sought to explore the extent to which there may be differences in both behavioral and demographic characteristics between strategic players and non-strategic players. We found one significant difference across all models tested, leading to the conclusion that in this study, the SP algorithm chose influential network members independent of demographic characteristics and most behavioral characteristics, though there was a statistically significant association between drinking frequency and SP status, with heavy drinkers in the SP group drinking less frequently.

As expected, SP set members and non-SP set target group members differed by network characteristics. Three of the six network characteristics tested had highly significant differences between SP and non-SP members. Those who were identified as SPs tended to have nominated fewer people (lower outdegree) than their non-SP heavy drinking peers, and as a result, SPs also tended to have lower mutuality of relationships than their peers, since they were less likely to reciprocate relationships. As per the design of the SP method, SP members were identified to be more connected to members of their own group, and as a result we see that the betweenness centrality is significantly lower among SPs, indicating that SPs tend to not serve as a bridge between different social groups.

We found that there were very minimal demographic differences between SP set members and non-SP set target group members. These non-significant results are consistent with the notion that an individual's position within the network (the basis of the SP procedure) was not related to race, sex, athlete status, etc. Similarly, we observed one (out of six) statistically significant difference in drinking variables for SP set members and non-SP target set members, in that SP set members had lower drinking frequency than non-SP target

set members. Notably, though frequency of drinking differed, frequency of heavy episodic drinking episodes, the primary variable that defined the target group, did not significantly differ between SP and not SP heavy drinkers. Therefore, while there is evidence for an association between SP status and drinking behavior, we have no evidence for an association between SP status and the primary drinking variables of interest (frequency of heavy drinking episodes).

As the strategic player method is adopted to identify network intervention recipients, it will be important for researchers to consider the possibility that SP selection may be associated with factors besides network position, particularly if network position is related to these characteristics. For example, in this study we have evidence that drinking frequency might be associated with network position and therefore SP status. When making comparisons between the SP and non-SP target members it may be advisable to control for differences such as these. Furthermore, it will be important to consider whether the network characteristics that did differ between SPs and non-SPs are important for diffusion of behavior change. For example, the low betweenness centrality among SPs could compromise diffusion. Future work may modify the SP approach to incorporate other variables in the selection process, as well to increase the contribution of this approach to social network interventions.

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**Table 1.**

Demographic, Drinking, and Network Variables

| | SP heavy drinkers (*n* = 145) N (%) or M (SD) | non-SP heavy drinkers[1] (*n* = 384) N or M (SD) | *t* or $\chi^2$ | *P* |
|---|---|---|---|---|
| **Demographics** | | | | |
| Race (Non-Hispanic White) | | | 3.06 | 0.08 |
| Yes | 72 (50.7) | 225 (58.9) | | |
| No | 70 (49.3) | 157 (41.1) | | |
| Sex | | | 1.97 | 0.16 |
| Male | 78 (53.8) | 179 (46.6) | | |
| Female | 67 (46.2) | 502 (53.4) | | |
| **Drinking** | | | | |
| Drinking frequency | 7.50 (2.93) | 8.45 (3.29) | 3.04 | **0.003** |
| Drinks per week | 9.53 (7.59) | 10.44 (6.61) | 1.34 | 0.18 |
| Frequency of HED[1] | 4.71 (2.56) | 5.13 (2.95) | 1.51 | 0.13 |
| Max drinks | 8.79 (4.06) | 8.49 (3.68) | −0.81 | 0.42 |
| BYAACQ[2] sum | 4.96 (3.20) | 5.45 (3.51) | 1.48 | 0.14 |
| **Network Variables** | | | | |
| Indegree | 6.22 (2.89) | 6.29 (3.15) | 0.21 | 0.83 |
| Outdegree | 3.90 (3.33) | 6.34 (2.66) | 8.75 | **<.001** |
| Mutuality | 0.32 (0.25) | 0.39 (0.20) | 3.63 | **<.001** |
| Eigenvector centrality | 0.01 (0.02) | 0.01 (0.01) | 1.46 | 0.15 |
| Betweenness centrality | −0.24 (0.89) | 0.20 (1.12) | 4.22 | **<.001** |
| Ego density | 0.24 (0.17) | 0.23 (0.16) | −0.38 | 0.70 |
| **Other Variables** | | | | |
| Readiness to Change Drinking | −2.55 (2.91) | −2.37 (3.33) | 0.58 | 0.57 |
| Alcohol Self-Efficacy | 88.63 (15.34) | 88.30 (15.63) | −0.21 | 0.83 |
| Drinking Motives | 32.23 (7.28) | 32.74 (7.22) | 0.73 | 0.47 |
| Resistance to Peer Influence | 28.68 (3.73) | 28.80 (4.01) | 0.33 | 0.74 |
| Perceptions of Own Behavior | | | | |
| Been supportive of others deciding not to drink | 6.65 (15.52) | 8.57 (19.64) | 1.06 | 0.29 |

Notes. SP=Strategic Player

[1]HED = Heavy episodic drinking defined as two or more heavy drinking occasions in the past 30 days (4+ for female/5+ for males).

[2]BYAAC= Brief Young Adult Consequences Questionnaire